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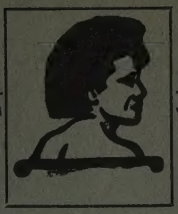

COLONY OF FIJI

AGRICULTURAL JOURNAL

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Vol.			Vol.		
1.	3 numbers,	1928.	13.	4 numbers,	1942.
2.	4 ,,	1929.	14.	4 ,,	1943.
3.	3 ,,	1930 (none).	15.	4 ,,	1944.
4.	4 ,,	1931.	16.	4 ,,	1945.
5.	2 ,,	1932 (none of No. 2).	17.	4 ,,	1946 (none of No. 1).
6.	2 ,,	1933.	18.	4 ,,	1947 (none of No. 1).
7.	1 ,,	1934.	19.	4 ,,	1948 (Nos. 3 and 4 form a double issue).
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9.	4 ,,	1938 (none of Nos. 2, 3 and 4).	20.	4 ,,	1949.
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12.	4 ,,	1941 (none of Nos. 1 and 2).	22.	1 ,,	1951.
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ISSUES OF AGRICULTURAL CIRCULAR

NUMBERS and year of issue of the "Agricultural Circular" :—

Vol. 1, 1920, 12 numbers. Vol. 4, 1923, 1 number.
2, 1921, 5 ,, 5, 1924-5, 2 numbers.
3, 1922, 4 ,,

As number 4 of Vol. 3 was printed as "Volume 4" and number 1 of Vol. 4 as "Volume 5" it would appear from an inspection of a complete set that Volume 4 comprised only a number 4 and that there were two issues of Volume 5, No. 1.

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—EDITOR

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CORRIGENDA.

(Attention of readers is drawn to an error in numbering the pages of Volume 23 No. 2—which should read from 33 to 64. The pages of the current double number (Nos. 3 and 4) threrefore commence at page 65. Readers are advised to make the necessary amendment in their copies which were issued before the error was noticed. Ed.)

ISSUED BY THE DEPARTMENT OF AGRICULTURE, FIJI.

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EDITORIAL . . .

CLIMATE AND DAIRY CATTLE

THE TWIN CALF EXPERIMENT

The experiment dealing with climatic studies on identical twin calves was completed at Sigatoka and the Ruakura Livestock Experimental Station in June of this year. It will be recalled that this project was carried out in co-operation with the New Zealand Department of Agriculture and was grant-aided by the South Pacific Commission.

2. The purpose of the experiment was to obtain basic information on the productivity of European type animals in a tropical climate. One series of twins was kept at Ruakura, (The Animal Research Station of the New Zealand Department of Agriculture) and the other on the Sigatoka Agricultural Station, Fiji. Both series were fed identical food and the management at both stations was standardized. The basic ration was New Zealand lucerne hay and both series received a supplementary concentrate of coconut meal produced in Fiji.

3. A full report of the findings of this experiment will be published in the *Empire Journal of Experimental Agriculture* in 1953 and further work based on the findings of this experiment is planned at Sigatoka.

4. This is the first experiment in which an attempt has been made to evaluate quantitatively the effects of climate on the growth and production of European type dairy stock. By using identical twins with identical nutrition and management a greater measure of certainty can be given to the results of the experiment. As indicative of the attention to detail, identical twin bulls were used on the twin sets at both stations.

5. The heifers were transferred to Fiji at 6 months of age and they calved at approximately two years. At two years of age all the New Zealand animals were heavier than the Fiji set; the minimum weight difference was 38 lb, the maximum 182 lb with a mean of 90.6 lb.

6. Of considerable interest were the findings that butterfat percentage was lower in the Fiji series and that milk production was also adversely affected by the tropical environment.

7. Many tests on blood constituents, red cell counts etc., were undertaken but no marked differences were observed in these and many other physiological characters with the exception of water intake which was much higher in the Fiji twins.

8. The general conclusion is that there would appear to be some form of physiological limit to growth and production of European type dairy stock in a tropical environment, particularly during the hot wet months, but that there is considerable variation between individual animals in their ability to acclimatise.

9. Other work at Sigatoka has shown that there are strains of European breeds of livestock with a high heat tolerance and the practical answer to herd improvement may lie in the importation of sires, not only of good productive capacity based on pedigree but also with a high measure of heat tolerance.

10. The twin calf experiment focuses attention on the importance of breeding livestock which are adaptable to a tropical environment ; a high plane of nutrition is not enough. Apart from heat tolerant strains of European breeds it would appear that attention must be given to animals with Zebu blood such as the Red Sindhi Jersey Cross dairy stock and the Santa Gertrudis beef breed evolved on the King Ranch Texas by the crossing of European Shorthorn cattle and the Nellore strain of Zebu.

—W.J.B.

AGRICULTURE . . .

RICE IMPROVEMENT PROGRAMME

REPORT OF THREE YEARS TRIALS 1949-52

NORMAN LAMONT ECONOMIC BOTANIST

INTRODUCTION

The fact that most of the Colony's rice is grown as a subsistence crop which is neither bought nor sold in the markets, does not in any way detract from its importance in the economy of Fiji. It is estimated that about 36,000 acres are grown annually and the produce of this can reasonable be valued at the present time as over £1,000,000 annually. Accordingly any improvement in the Colony's rice crop, which our work at Koronivia might bring about, would produce a very substantial increase in the national income in a very short space of time.

Since furthermore it is an annual crop productive of relatively quick results from improvement work, rice was placed high on the priority list of projects when the new station commenced operations in 1949. With the completion of three consecutive years of trials, a phase of our work is for all practical purposes completed and a report to date is appropriate.

RICE IMPROVEMENT PLAN.

The improvement plan at Koronivia, which will be a perennial one, consists in simplest terms of the testing of new varieties, the production for general sale nucleus seed of proven varieties and the investigation of cutural methods likely to increase yield or cheapen production.

It is obvious that radical change in farming practice is not easy to bring about quickly and as a consequence our main efforts have been directed towards varietal improvement. The first phase of this has the thorough examination of existing varieties and this work after three years has reached a stage when fairly definte conclusions can be recorded.

Although we are attempting a little selection and breeding work on the New Guinea variety, we are not really equipped or staffed for highly technical plant breeding but will have to rely upon introductions from better equipped overseas institutions.

During the current season about two dozen new introductions will be under trial at Koronivia and it may be that some of real value to the Colony will emerge. The thorough testing of three varieties is a fairly exacting operation and should be carried out over at least three seasons. When we are certain that a variety has merit for our conditions, seed will be increased and made available for sale through the Extension Division.

VARIETAL POSITION IN FIJI.

Most attention over the past three years has been given to about twelve varieties, some already popular in the Colony, which from previous work appeared to be the superior varieties in use. Most of these were earlier Departmental introductions notably from British Guiana while some were of quite obscure origin as for example the very popular and useful New Guinea. At the same time with the co-operation of the Extension Division a survey of the Colony's rice varieties was undertaken. Samples were collected from rice growers in different parts of the Colony and grown at Koronivia beside our own selected varieties for comparison.

This survey was most revealing in many respects and was also reassuring in that our own seed, grown under identical conditions, was so clearly superior to almost all of the samples submitted and clearly inferior to

none. It is significant that over half of the samples received were either incorrectly named by the growers or so hopelessly mixed that almost any name would pass. We have no doubt that the number of varieties of rice grown in Fiji is excessive and is not justified by the variation in growing conditions that exist. Not only does this lead to hopeless cofusion but it is also probably responsible for lower field and milling yields.

The bulk of our variety trials have been grown by prevailing peasant farmer methods with no particular treatment or fertilisers that differ from everyday practice. As a consequence, we feel confident that if we can regularly produce over one ton and sometimes over two tons of padi per acre from some varieties as compared with the Colony average of half to threequarters of a ton, we have a very real contribution to make in supplying clean pure seed of these good varieties to growers.

VARIETY EXPERIMENTAL RESULTS

HAND-PLANTED TRAILS.

The form of the trials has changed a little over the three years and although in some directions information is lost thereby, it was felt that this was more than made up in other respects.

The 1949-1950 and the 1950-51 hand-planted trials were identical, being Latin square designs, each being duplicated as a mid and a late season planted trial. The results in tons per acre were as follows:—

Variety	Mid Season planted			Late planted		
	1949-50	1950-51	Mean	1949-50	1950-51	Mean
New Guinea	1.04	1.13	1.09	1.06	0.78	0.92
B.G. 75	1.38	1.13	1.26	0.97	0.83	0.90
B.G. 79	1.28	1.11	1.20	...	...	...
Ramcajara	1.33	0.90	1.12	0.95	0.77	0.86
China Patna	...	...	...	1.01	0.82	0.92
Motka	...	...	...	1.13	0.79	0.96
D. 116	1.19	1.04	1.12	...	...	...
Demerara Creole ...	1.17	1.09	1.12	...	...	...
Blue Stick	0.99	1.10	1.13	...	...	...
Chetwa	0.74	0.34	0.54	...	...	...
Sonacalif	...	...	...	0.02	0.02	0.02
Means	1.14	0.98	1.06	0.86	0.67	0.72
Sig. diffs. 5%	0.21	0.19	...	0.14	0.20	...

In view of the evident importance of planting time the 1951-52 series were planted at three different times at about three weekly intervals commencing with late October seeding and mid-December planting. Again two series of trials were carried out, the first on eight of the varieties used previously and the second including three new British Guiana introductions. The results, again in tons per acre were as follows:—

	A	B	C
Variety-Seed sown	24/10/51	21/11/51	15/12/51
—Planted	12/12/51	4/1/52	24/1/52
Ramcajara	0.91	0.79	0.37
New Guinea ...	0.62	0.79	0.65
B.G. 79	0.91	0.87	0.45
China Patna ...	0.89	0.71	0.58
Motka	0.75	0.64	0.69
Demerara Creole ...	1.15	0.81	0.50
D. 116	0.92	0.66	0.34
B.G. 75	0.92	0.85	0.43
Sign. diff. 5% ...	N.S.	N.S.	0.20
Means	0.88	0.76	0.50

And for the smaller trial of the new introductions:—

	A	B	C
Variety-Seed sown	24/10/51	21/11/51	15/12/51
—Planted out	13/12/51	4/1/52	24/1/52
B.G.D. 95/42 ...	2.10	1.79	1.23
B.G.D. 85/42 ...	1.82	1.78	1.34
B.G. 75	2.20	1.83	1.37
B.G.D. 54/42 ...	2.26	1.88	1.47
New Guinea ...	0.67*	1.50	1.41
Sign. diffs. 5% ...	0.25	N.S.	N.S.
Means	1.81	1.76	1.36

DRILLED VARIETY TRIALS.

In 1950-51 varieties were compared also as drilled rices on relatively dry land and this was replanted much more extensively in 1951-52, when the practice used with the

* Extensive bird damage due to earlier maturity of New Guniea.

hand-planted trials of sowing at three different times was adopted. Results were as follows:—

Variety	1950-51	1951-52		
Sowing date	12-12-50	9-11-51	24-12-51	14-1-52
New Guinea .	1.34	0.88	0.81	0.87
B.G. 75 ...	1.13	1.25	1.10	0.78
Ramcajara ...	1.26	1.04	1.09	0.83
B.G. 79 ...	1.09	1.03	1.00	0.77
D. 116 ...	1.17	0.97	0.95	0.87
China Patna .	0.82	0.58	0.37	0.61
Motka ...	...	0.37	0.31	0.62
Bandala ...	0.64	0.90	0.43	0.42
Sonacalif ...	0.49	...	...	...
Means ...	1.13	0.88	0.76	0.72

The above yield figures have been given for the information of those who may wish to study them in detail and before a definite recommendation can be made, a considerable amount of sifting of the data is required with due allowance also for other factors. The following points of interest should be noted.

(*a*) *Effect of method of planting.*—A genuine comparison of drilling versus hand-planting of rice is not entirely easy to secure. Naurally drilling tends to be done on the drier areas which at Koronivia are the areas which have been most heavily cropped in the past whereas some of the hand-planted experiments have been located on relatively humus rich freshly developed swamps.

After making due allowance for site, time of planting, etc., we feel that at present we cannot say that any difference in yield can be expected amongst the better varieties due to the two methods of planting. Furthermore it is clear too that the same varieties excel whether drilled or hand-planted.

The average yields of the seven varieties of the main series of 1951-52 variety trials common to both drilled and hand-planted plots were as follows:—

	Early	Midseason	Late
Drilled	0.88	0.81	0.76
Hand-planted ...	0.84	0.75	0.50

(*b*) *Effect of time of planting.*—In the table immediately above the falling off in yield due to later planting is apparent and for some reason, at present inexplicable, this is more marked in the hand-planted than in the drilled trials.

In the following tables yields are presented as percentages of the average for each trial and there is shown also the relative fall in production of the mid and late season plantings compared with the early planting.

DRILLED TRIALS 1951-52.

Variety	Relative Yields			Mid as % of early	Late as % of early
	Early	Mid	Late		
B.G. 75	142	145	108	88	62
Ramcajara	119	143	117	105	81
B.G. 79	117	132	107	97	75
D. 116	111	125	121	98	90
Bandala	103	57	58	48	47
New Guinea	100	107	121	92	99
China Patna	66	49	85	64	105
Motka	42	41	86	98	167
Means	100	100	100	86	82

Similar calculations for the hand-planted trials are as follows:—

HAND-PLANTED TRIALS 1951-52.

Variety	Relative Yields			Mid as % of early	Late as % of early
	Early	Mid	Late		
Demerara Creole	132	105	100	69	43
B.G. 75	105	112	84	92	46
D. 116	105	87	68	72	37
B.G. 79	103	113	90	95	49
Ramcajara	103	103	74	86	41
China Patna	101	93	116	79	65
Motka	85	84	138	85	92
New Guinea	70	104	128	127	103
Means	100	100	100	86	57

Again we must apologise for a fairly considerable mass of figures but some may be interested in studying these in detail and drawing their own conclusions.

Taking the relative yield columns vertically the relative yields of the varieties can be seen at a glance, expressed as percentages of the average of the eight varieties. The last two columns show how severely, if at all, each variety was affected by the later sowing or planting.

Although the design of the 1949-50 and 1950-51 trials does not lend itself so readily to this form of analysis an indication of the same trends is evident in them. Our own conclusions based on the three years work are as follows:—

(i) The varieties B.G. 75, Ramcajara, and B.G. 79 appear to be our best yielding varieties when planted early and they are closely followed by D 116 and Demerara Creole. All of these varieties are, however, susceptible to delays in planting and generally their yield is depressed thereby.

(ii) The varieties New Guinea, China Patna and Motka on the other hand are relatively unaffected by late planting and may outyield the B.G. varieties where late planting is unavoidable.

(*c*) *Susceptibility to rice yellows.*—Closely related to effect of time of planting is susceptibility to rice yellows. A moderate attack was experienced on Koronivia ni 1951-52 and it was very strikingly evident that only the latest, hand-planted trials were affected. This may account in part for the very obvious drop in yield of the late-planted blocks which averaged only 57% of the early.

The presence of " yellows " in replicated variety trial blocks on Koronivia in 1951-52 presented us with the first opportunity we have had for fairly accurately assessing the relative susceptibility of varieties to this condition. Our conclusions were as follows:—

Yellows symptoms absent or very slight—New Guinea.

Symptoms slight to moderate—China Patna, Motka.

Symptoms moderate to severe—D. 116, Ramcajara.

Symptoms generally severe—B.G. 75, B.G. 79, Demerara Creole, Bandala B.G.D. 85/42.
B.G.D. 85/42.

It might be mentioned incidentally that some measure of direct control of this condition was secured this season by the use of D.D.T. spraying. As the Senior Entomologist, Mr. B. A. O'Connor has demonstrated on a number of occasions, rice yellows can be caused by the Sogata leaf-hopper and these insects were present in large numbers where rice yellows was found on Koronivia.

On spraying strips with D.D.T. a very clearly visible improvement in the appearance of the rice resulted but on this block the condition was not in any case severe and no significant increase in grain yield resulted from the treatments.

(*d*) *Milling yields.*—The following figures for milling yield have been secured for our main varieties over the past three years:—

Variety	49-50	50-51	51-52	Means
New Guinea ...	63%	79%	67%	69.6
Motka	61	72	66	66.3
Demerara Creole .	60	70	...	65.0
China Patna ...	59	70	66	65.0
D. 116	66	64	67	65.6
B.G. 75	62	65	67	64.6
Ramcajara ...	62	64	70	65.3
B.G. 79	58	64	65	62.3
Chetna	61	63	...	62.0
Bluestick ...	60	60	...	60.0
Jhinwa	40	64	...	52.0
Bandala	...	68	73	70.5
B.G.D. 54/42 ...	...	...	66	...
B.G.D. 85/42 ...	...	...	68	...
B.G.D. 95/42 ...	...	...	68	...

In each year different millers have been employed and it is fairly evident that the miller can substantially influence the relative milling yield of varieties. Since it is clear that all of our best varieties have somewhat similar yields, this factor need not be taken seriously into account. It might perhaps be mentioned that these figures are all based on samples that had been thoroughly machine winnowed and are probably all rather higher than one could expect from ordinary commercial samples.

(*e*) *Flavour.*—A simple investigation into this subject has already been reported. Suffice to say here that all B.G. varieties

appear popular eating varieties but that the moderate flavour score of New Guinea and China Patna does not appear to seriously prejudice their popularity with the grower. Flavour is a factor that may be considered but with discretion.

SUMMARY AND RECOMMENDATIONS RESPECTING VARIETIES.

It is fairly clear from the data presented that the differences between a number of our varieties is not very great and that we have no valid grounds for eliminating some of the leaders. On the other hand, we believe it is sound policy to concentrate upon a few good varieties of proven value and not to release new introductions unless or until they they have proved themselves clearly superior to our present lines. For instance the three new B.G. varieties under trial have not as yet indicated any significant superiority over B.G. 75 and since they are in any case indistinguishable from each other, pointless confusion would arise if they were distributed amongst grower.

Personal fancy will undoubtedly influence growers perhaps as much as departmental recommendations but we feel that the Colony would not fail to benefit greatly if B.G. 75 and Ramcajara were used for all sowings and plantings where seed can be put in not later than mid-November. Until we know more of the control of rice yellows New Guinea is clearly the recommendation for late planting.

OTHER RICE INVESTIGATIONS.

This account is intended primarily to summarise three seasons varietal work but brief mention may be made of other lines of investigation that are proceeding although most of the mechanisation studies, fertiliser and cultural work generally has not yet proceeded far enough for positive recommendations to be made.

(*a*) *Mechanisation.*—Experience on the problems of mechanising rice production is accumulating all the time although limited on occasion by the multiplicity of small varietal plots that we have. Already we have satisfied ourselves that drilled rice will produce as well as rice hand-planted according to ordinary small farmer practice. It is clear that drilled rice can be established for about as many shililngs per acre as it costs pounds to hand-plant.

We have found too that the ordinary methods of cereal harvesting such as stooking or cocking are not satisfactory under wet zone conditions and only a standing crop can quickly dry out after the brief but very wet tropical showers we experience around harvest time. At the moment, we feel our efforts should be directed towards the mowing of the standing crop either with the object of taking it to a stationery mill or possibly directly with a combine harvester. Our variety introductions this season have been specifically selected with the object of trying to discover a strong strawed, non-shattering type of rice which will be amenable to mechanical harvesting.

(*b*) *Fertiliser trials.*—If one may judge from publications we share with many overseas countries a most aggravating and at times baffling inconsistency of responses by rice to fertiliser application. Only sulphate of ammonia promises any measure of consistent returns and we hope by the end of this present season to have ascertained sufficient of the correct time and rate of application to enable us to make definite recommendations. To date response by different varieties has been very variable but future work can now be confined to the varieties which we will consider our standards. Average responses over all varieties have ranged from 11% to nearly 30% following applications of 2 cwt. per acre of sulphate of ammonia. This rate costs about £2 10s. per acre so that even 11% on a ton to the acre crop is very profitable.

(*c*) *Weed Control.*—On well drained land efficiently and cleanly cultivated through a series of rotation crops, it should be possible to grow a crop of rice without undue weed problems and we have on occasion succeeded in so doing. More often the land is weedy and a proper "cleaning" bare fallow is difficult to secure. We have found considerable benefit from lightly harrowing the rice crop when it is about 9 inches high and when the weed seedlings are just commencing to germinate and we propose as soon as

materials come to hand, to investigate chemical methods more fully. Up to the present, however, we find that on dry areas, even though the crop remains fairly clean up to harvest time, there is every likelihood that, in the last couple of weeks before threshing, sensitive grass particularly may almost take over. Drilling in 14" rows and hand weeding it is to date the only answer to this problem.

(*d*) *Hand-planting methods.*—Despite our interest in mechanisation we must recognise that hand-planting is and will remain perhaps the most usual method of rice planting in the Colony. Consequently work has been commenced on seed-bed fertilising and upon planting densities in the field as we have indications that improved yield may be expected from strong vigorous seedlings and that the conventional planting density is unduly great.

(*e*) *Single plant selections.*—In veiw of its special characters—notably indifference to planting time and resistance to yellows—we have endeavoured to give special attention to the New Guinea. We felt too that, since most lines of this variety appeared mixed in respect to type with long sustained flowering periods, we might be able to effect improvement by selection. Accordingly about 8,000 single plants were put out last year from which 20 only have been selected for further examination this year. If we are fortunate enough to find that the characters we have selected are strongly inherited a vastly improved strain of New Guinea should result.

CONCLUSION.

As pointed out elsewhere Koronivia is essentially a farm operating to a programme including many items besides rice and although we recognise the importance of our rice work, our farming routine must impose a limit to the area we can grow as also does our staff and financial allocation. In the immediate future we anticipate being able to grow 15 to 20 acres annually of which about one quarter will be required for experimental work only and three quarters will be available for seed production as well as certain types of experimental work.

It is our intention to concentrate our efforts on the production of pure clean seed of the few recommended varieties listed above. This seed will, as in the past, be carefully rationed to purchasers and every effort made to see that it is used for further seed production. Even if this is only partially successful the return to the Colony within a year or two should be vastly in excess of the total establishment cost of the Koronivia Station.

A SURVEY OF COCONUT AREAS IN FIJI AS AT 31ST DECEMBER, 1950

BY L. W. HARWOOD, H.D.A., AGRICULTURAL OFFICER SOUTHERN

Following on the survey of coconut areas in the Northern Agricultural Division completed in 1946 an estimate of the acreage under palms in the Colony (excluding the island of Rotuma) has been prepared. The survey was compiled from information collected from visits to practically every estate, settlement and native town in the Colony. Estimates, based on known production of copra, were made for the smaller outlying islands of Lau.

The absolute accuracy of the survey cannot be guaranteed. It does, however, represent the first reasonably accurate assessment of acreages under palms since the establishment of the industry.

The coconut industry was established on plantation lines soon after the expiration of the American Civil War and the collapse of the cotton market. It is therefore approximately 80 years old. No information on the acreages under crop is available prior to 1921. In that year the annual report of the Department of Agriculture gave the acreage of European owned coconuts as 37,465 acres (in bearing) and 13,896 acres not in bearing, a total of 51,361 acres. In 1922 the figures were 35,400 acres and 15,584 acres respectively making a total of 50,984 acres of productive coconuts owned by European planters. The total acreage of productive coconut palms in 1923 was estimated at 78,400 acres. It will be seen therefore that in 1923 estates accounted for 35,400 acres of productive palms as against 43,000 acres owned by Fijians. Figures for the recently completed survey are: estates—palms in bearing 68,607 acres ; and Fijian owned—80,545. In 1923 45.2 per cent of the productive palms were estate planted and 54.5 per cent Fijian owned. Corresponding figures for 1950 are 46.1 per cent and 53.9 per cent respectively.

ANALYSIS OF THE SURVEY.

Recorders divided the coconuts into five categories, viz under 8 years of age (not in bearing), 8—20 years of age, over 20 years but under 35 years of age, over 35 years but under 50 years of age, and over 50 years of age. It is therefore possible to provide estimates of the acreages of palms not yet in bearing, productive palms, and those which have passed their period of maximum production. An examination of the various age groups enables us to calculate the annual plantings which should be made to maintain the industry at its present production.

TABLE I.

Acreages under palms by age groups and divisions.

Division	A Under 8 yrs. (not bearing)	B 8-20 years	C 21-35 years	D 36-50 years	E Over 50 years	Total
Western ...	620.0	901.5	1,517.0	1,740.5	2,245.7	7,024.7
Southern ...	7,471.7	12,553.7	16,440.5	18,016.6	9,319.2	63,801.7
Northern ...	5,383.8	7,762.1	16,901.0	21,781.4	39,972.7	91,801.0
	13,475.5	21,217.3	34,858.5	41,538.5	51,537.6	162,627.4

The acreage of palms not yet in bearing is thus 13,475.5 acres while productive palms account for 149,141.9 acres. For the purpose of this survey it has been assumed that the economic life of a coconut palm is approximately seventy years. It may therefore be safely assumed that 51,537.6 acres of palms or 31.7 per cent of the crop have definitely passed their period of optimum production. Furthermore the palms in column " D " are also approaching the age when yields will tend to diminish. It will be noted that 93,076.1 acres of palms or 57.3 per cent of the crop are in the older age groups whilst only 13,475.5 acres or 8.3 per cent of the palms are not yet in bearing. It would appear therefore that if annual plantings are not made we may anticipate reduced copra production in the very near future.

Table II on page 13 reveals that the principal coconut areas are the provinces of Cakaudrove, Lau, Lomaiviti, Bua and Macuata, 90.6 per cent of the Colony's acreage being in these areas. The largest Fijian acreages are in Lau, Cakaudrove, Lomaiviti, Bua and Macuata in that order whilst the largest estate acreages are to be found in Cakaudrove, Lau, Bua, Lomaiviti and Macuata respectively.

In all provinces for all types of producers the greater proportion of the palms are in the older age groups. 91,170.1 acres or 56.1 per cent of the crop are grown by Fijians and 71,457.3 acres or 43.9 per cent by estate owners.

The distribution of the total planted acreage by provinces is shown hereunder:—

Cakaudrove	40.9	per cent
Lau	24.9	,,
Lomaiviti	9.4	,,
Bua	8.8	,,
Macuata	6.8	,,
Nadroga-Navosa	2.6	,,
Ba	1.7	,,
Tailevu	1.5	,,
Kadavu	1.4	,,
Rewa	.8	,,
Other areas of little commercial importance ...	1.2	"

The survey is valuable in that it gives a clear picture of the state of the industry in the various parts of the group. The earlier survey of the Northern Division was also useful in that it enabled plans for new plantings and rehabilitation of existing areas to be prepared.

This survey was an essential pre-requisite to the coconut planting and rehabilitation project launched by the Department of Agriculture in collaboration with the Fijian Affairs Board in 1951. This project has for its main object the planting of suitable Fijian owned lands to coconuts. To date progress has been very satisfactory, 1,064 acres of coconuts having been planted and 153,927 selected seed nuts having been placed in nurseries in 1951. The known acreage of coconuts as at 31st December, 1951, is as shown in Table III.

TABLE III.

Coconut acreages as at 31/12/51, including recent plantings.

	Planted 1950 (ac.)	Planted 1951 (ac.)	Total (ac.)
Western Division.			
Ba	2,812	11	2,823
Nadroga-Navosa	4,213	50	4,263
Total	7,025	61	7,086
Southern Division.			
Kadavu	2,324	36	2,360
Lau	40,462	...	40,462
Rewa	1,348	20	1,368
Serua	453	43	496
Tailevu	2,439	...	2,439
Ra	1,242	1	1,243
Naitasiri	111	...	111
Namosi	118	...	118
Lomaiviti	15,304	...	15,304
Total	63,801	100	63,901
Northern Division.			
Macuata	11,022	426	11,448
Bua	14,297	...	14,297
Cakaudrove ...	66,482	477	66,959
Total	91,801	903	92,704
Total for Colony .	162,627	1,064	163,961

REPLANTING PROGRAMME.

The annual plantings necessary to maintain the industry at its present production have been calculated for nine years and are shown hereunder:—

1st year	3,784	acres.
2nd ,, ...	3,773	,,
3rd ,, ...	3,786	,,
4th ,, ...	3,796	,,
5th ,, ...	3,851	,,
6th ,, ...	3,803	,,
7th ,, ...	3,804	,,
8th ,, ...	3,802	,,
9th ,, ...	3,796	,,

In making these calculations the following assumptions have been made:

(1) The economic life of a coconut palm is seventy years.

(2) One-eigth of the palms in the first age group will pass into the next group, one-twelfth of those in group B to group C, one-fifteenth of those in group C to group D, one-fifteenth of

those in group D to the fifth age group each year. One-twentieth of the last age group will die annually.

(3) Allowances bave been made for mortality in groups A, B, C and D. 5 per cent of the palms will die in their first year and 1 per cent annually each following year until they reach 50 years of age. The annual mortality after that age is estimated at 5 per cent of the age group.

Table IV shows the changes which would take place in the survey each year if the recommended annual plantings were made.

TABLE IV.

	Under 8 yrs. (ac.)	8-20 years (ac.)	21-35 years (ac.)	36-50 years (ac.)	Over 50 years (ac.)	Total (ac.)
1952	13,476	21,217	34,858	41,538	51,538	162,627
1953	15,345	20,922	33,953	40,677	51,730	162,627
1954	16,970	20,888	33,092	39,822	51,855	162,627
1955	18,380	21,059	32,296	38,975	51,917	162,627
1956	19,605	21,388	31,575	38,140	51,919	162,627
1957	20,961	21,593	30,936	37,321	51,816	162,627
1958	21,830	22,198	30,364	36,522	51,713	162,627
1959	22,578	22,855	29,886	35,746	51,562	162,627
1960	23,219	23,543	29,500	34,998	51,367	162,627
1961	23,765	24,248	29,200	34,282	51,132	162,627

It is felt that a survey of coconut areas is of particular value at the moment in that producers who after a long period of low prices and consequent insecurity are now enjoying a period of prosperity unique in the history of the industry. They are surely in the position to make the new plantings so necessary for the further stabilisation of the industry.

TABLE II.

Acreages under coconuts grown by Fijian growers and planters by age groups, provinces and divisions.

	A Under 8 yrs.	B 8–20 yrs.	C 21–35 yrs.	D 36–50 yrs.	E Over 50 yrs.	Total
	ac.	ac.	ac.	ac.	ac.	ac.
FIJIAN GROWERS—						
Western Division—						
Ba	336	353	645	602	275	2211
Nadroga-Navosa ..	154	355·5	587	835·	1560·7	3492·7
Total ..	490	708·5	1232	1437·5	1835·7	5703·7
Southern Division—						
Kadavu	393	430	495·5	476·7	342·3	2137·5
Lau	2882·25	6398·5	7096	6055	3706·5	26138·25
Rewa	183	244	303	320	298	1348
Serua	86	40	46	46	32	250
Tailevu	285·5	1614·8	275	141·5	34	2350·8
Ra	320·8	382·4	191·6	22·5	4·5	921·8
Naitasiri	20·9	26	22·9	22	19·4	111·2
Namosi	25·5	25·5	25·5	23·5	10	110
Lomaiviti	1536·76	2485·6	3506·9	3607·4	1271	12407·65
Total ..	5733·7	11646·8	11962·9	10714·6	5717·6	45775·2
Northern Division—						
Macuata	716	598·1	1388	2442·4	2992·7	8136·2
Bua	2909	1120	1319	2164	1590	9102
Cakaudrove	776·5	1844·5	2671	3061	14100	22453
Total ..	4401·5	3562·6	5078	7667·4	18681·7	39691·2
Total Colony of Fiji ..	10625·2	15917·9	18572·4	19819·5	26235·1	91170·1

TABLE II (*Continued*)

Acrages under coconuts grown by Fijian growers and planters by age groups, provinces and divisions.

	A Under 8 yrs.	B 8–20 yrs.	C 21–35 yrs.	D 36–50 yrs.	E Over 50 yrs.	Total
	ac.	ac.	ac.	ac.	ac.	ac.
ESTATES—						
Western Division—						
Ba	130	103	195	123	50	601
Nadroga-Navosa ..	.....	90	90	180	360	720
Total ..	130	193	285	303	410	1321
Southern Division—						
Kadavu	33	35·4	45·1	44·5	28·5	186·5
Lau	1382	370	3810	6177	2585	14324
Rewa	....	....	....	....	....	....
Serua	24	45·5	41·5	43	49	203
Tailevu	21	45·5	17	3	2	88·5
Ra	75	44	112	89	....	320
Naitasiri	....	....	....	....	....	....
Namosi	1	2·5	2·5	1	1	8
Lomaiviti	202	364	450	944·5	936	2896·5
Total ..	1738	907·9	4478·1	7302	3601·5	18026·5
Northern Division—						
Macuata	183·8	318	1089·5	1054	240	2885·3
Bua	700·5	414·5	1489·5	2020	571	5195·5
Cakaudrove	98	3467	8944	11040	20480	44029
Total ..	982·3	4199·5	11523	14114	21291	52109·8
Total Colony of Fiji ..	2850·3	5299·4	16286·1	21719	25302·	71457·3
TOTALS—						
Western Division—						
Ba	466	456	840	725	325	2812
Nadroga-Navosa ..	154	445·5	677	1015·5	1920·7	4212·7
Total ..	620	901·5	1517	1740·5	2245·7	7024·7
Southern Division—						
Kadavu	426	465·4	540·6	521·2	370·8	2324
Lau	4264·25	6768·5	10906	12232	6291·5	40462·25
Rewa	183	244	303	320	298	1348
Serua	110	85·5	87·5	89	81	453
Tailevu	306·5	1660·3	292	144·5	36	2439·3
Ra	395·8	426·4	303·6	111·5	4·5	1241·8
Naitasiri	20·9	26	22·9	22	19·4	111·2
Namosi	26·5	28	28	24·5	11	118
Lomaiviti	1738·75	2849·6	3956·9	4551·9	2207	15304·15
Total ..	7471·7	12553·7	16440·5	18016·6	9319·2	63801·7
Northern Division—						
Macuata	899·8	916·1	2477·5	3496·4	3231·7	11021·5
Bua	3609·5	1534·5	2808·5	4184	2161	14297·5
Cakaudrove	874·5	5311·5	11615	14101	34580	66482
Total ..	5383·8	7762·1	16901	21781·4	39972·7	91801
Total Colony of Fiji ..	13475·5	21217·3	34858·5	41538·5	51537·6	162627·4

CONSTRUCTION OF A BULLOCK CART

BY T. L. MUNE, WEED CONTROL OFFICER

To-day with the high cost and scarcity of materials, the attached drawings will be of interest to the man who requires a bullock cart. A well constructed cart of this type will stand up to a lot of hard work and move heavier loads than a sledge with less strain.

WHEELS.—These require a log of not less than two and a half feet diameter, from which two blocks nine inches wide are cut. These blocks are marked off and cut down into the wheels. Any hardwood will do. Where a large tree is not available the wheels could be constructed from nine by two inch hardwood boards. Two sets of boards are cut and bolted together on the cross to make one wheel four inches thick. (See drawings). This type of wheel wears well as the grain of the wood in contact with the road is supported by the ends of the opposite timbers.

AXLES.—Six feet of six inch good straight hardwood is wanted for this. It is not necessary to square this off but as the body of the cart is fitted to the axle, it is easier to work on a square face. Cut each end of block down to make short round axles one foot in length and three inches in diameter. Two and a half inches from the end of these short axles drill a half inch hole. This it to take a wooden wedge which will keep the wheel on. In the centre of the axle block, cut a two by four inch mortise to take the end of the poll.

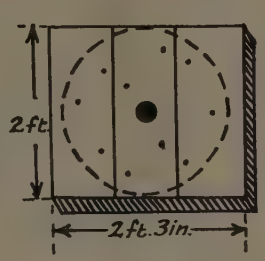
The Completed Cart.

POLE.—Construct the pole from twelve feet of four by four inch timber. The base of the pole is cut to fit the mortise in the axle block and is held there by a half inch bolt passed through the block. The head of the pole is fitted with an iron coupling made of quarter inch iron plates joined by a round dee.

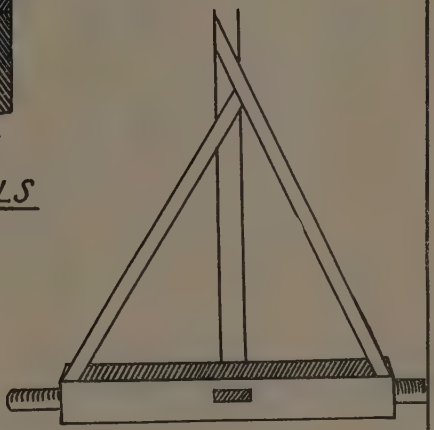
TRAY.—This is the body of the cart and is bolted directly to the axle by passing two half-inch bolts through the main beams and nailing the cross beams and flooring in place.

POLE SUPPORTS.—To stop side movement in the pole, two or three by two inch wooden braces are fitted under the tray, to the top of the axle. The left side one is extended three feet down the pole and the right side carried on another six inches. This allows both timber to be nailed on.

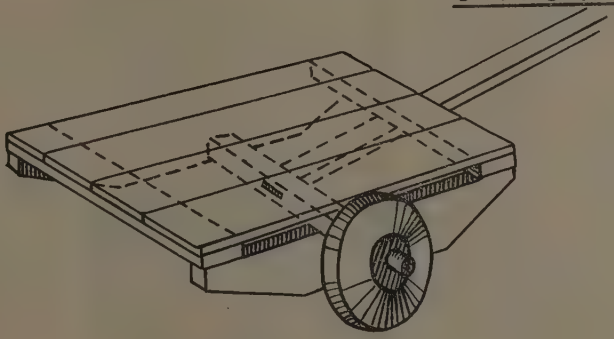
The wheels are fitted on without bearings, therefore it is necessary to keep the axle and wheel centre packed with yellow grease.



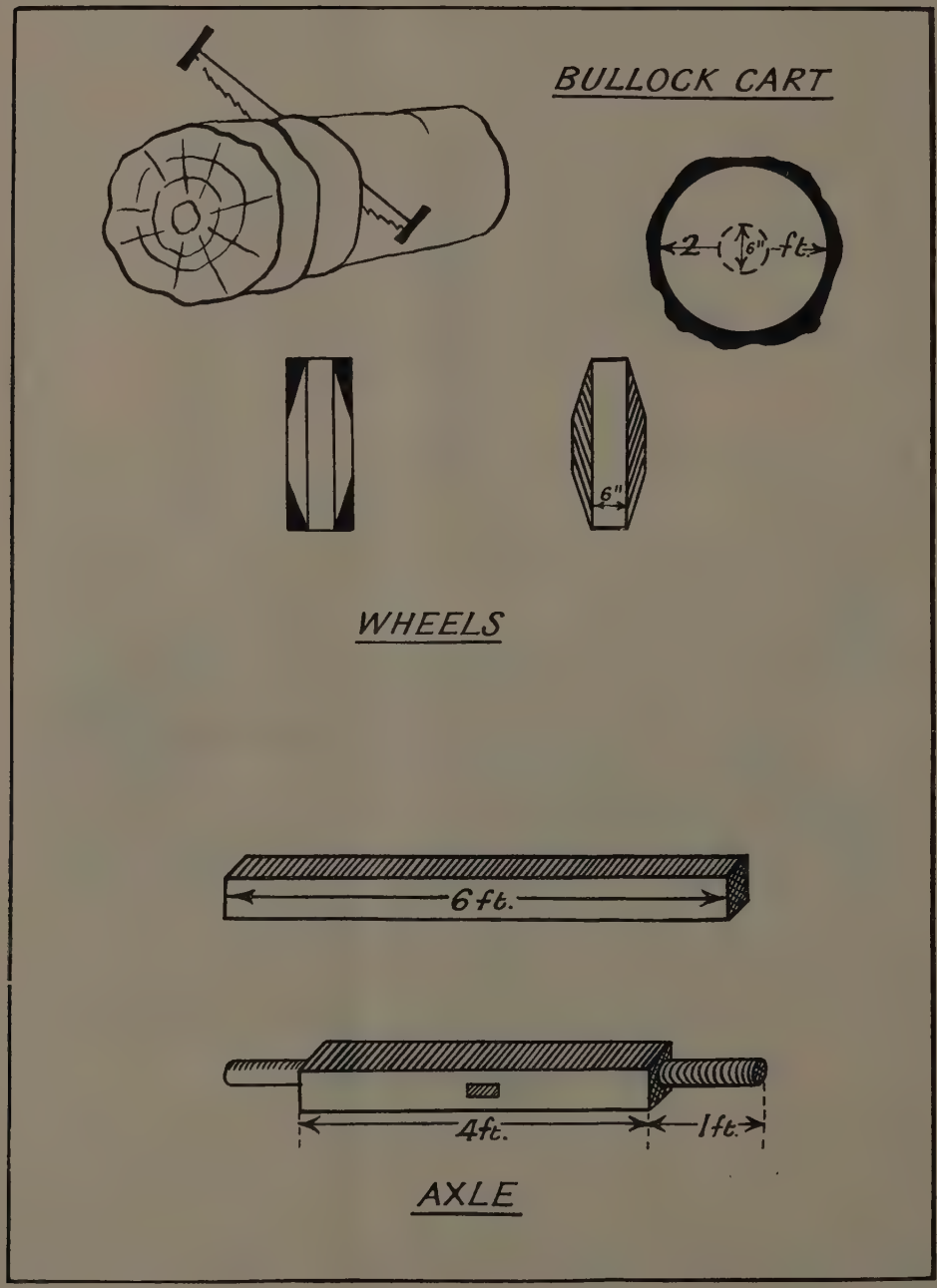
9"x 2" HARDWOOD WHEELS

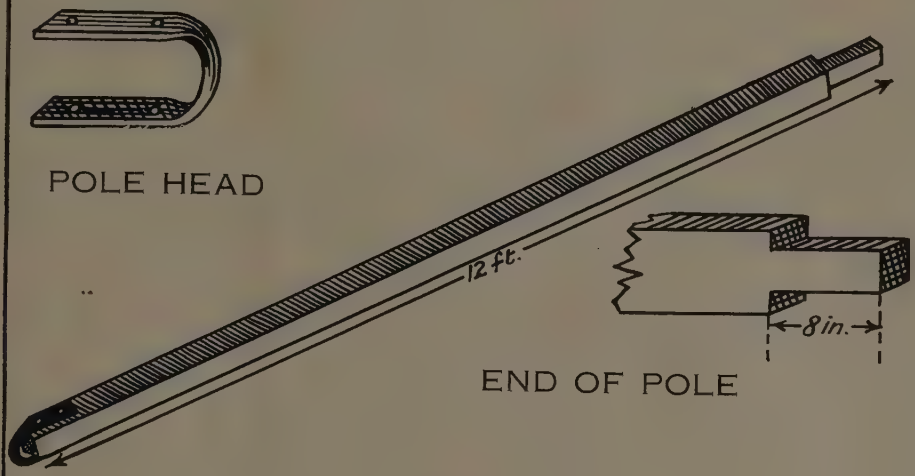


SUPPORTS

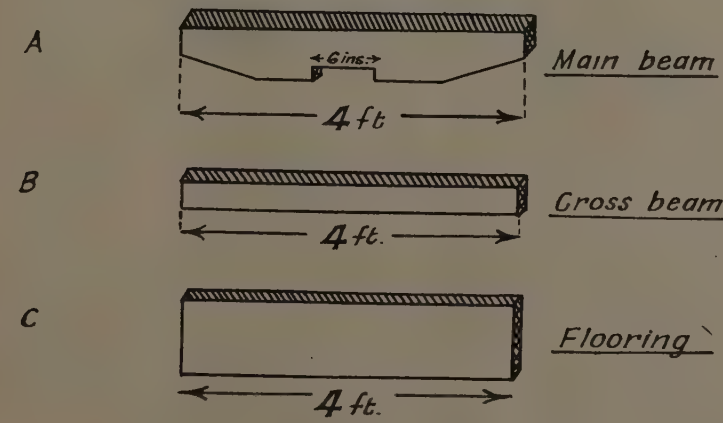


CART


BULLOCK CART
2 ft.
6"
6"
WHEELS
6 ft.
4ft.
1ft.
AXLE


POLE HEAD
12 ft.
8 in.
END OF POLE

POLE


A
6 ins.
4 ft
Main beam
B
4 ft.
Cross beam
C
4 ft.
Flooring

TRAY

CONCRETE FENCE POST MANUFACTURE

By NORMAN LAMONT

INTRODUCTION.

On account of the short life and relatively high cost of wooden posts, investigations were made on the Station to determine the costs of manufacture under local conditions, of reinforced concrete posts. It was found that we could make concrete posts actually cheaper than we could buy sagali posts and very much cheaper than we could buy buabua.

No doubt the cost of wooden posts varies in different parts of the Colony and similarly, accessibility of shingle and variable cartage costs of cement and iron will affect concrete post costs in other areas. The information given in these notes will enable those interested to calculate their local costs and decide whether the proposition is an attractive one, bearing in mind that there is little doubt that a good concrete post is worth more than the best of wooden posts.

Probably the only disadvantage of the concrete article is the somewhat greater weight. Those made at Koronivia weigh about 110 lb. as compared with 60 to 70 lb. for a wooden post of similar dimensions. For permanent fencing, when each post is handled only once in a lifetime this is not a serious disadvantage and is more than offset by the advantages of absolute uniformity, straightness, ease of attachment and repair of wires and of course the indefinite life of the concrete.

COSTS AND QUANTITIES.

The mixture recommended is five parts of "aggregate" to one part of Portland cement.

The aggregate should pass through $\frac{1}{2}$" sieve and contain about 40% of clean sharp sand. On the station we use river shingle screened through chicken wire. A good proportion of fine sand in the mixture is important and may have to be added.

Occasionally river shingle may consist entirely of very small stones, about $\frac{1}{8}$" and $\frac{1}{4}$", with no sand, and posts made from this will not be satisfactory.

Only sufficient water should be used to make the mixture wet enough to settle snugly into the moulds. If it is too wet water will run out of the moulds taking some of the cement with it and if too dry a porous post will be produced.

Reinforcing is often difficult to secure and anyone intending to make large numbers of posts might be well advised to import reinforcing in quantity. The ideal is $\frac{1}{4}$" or 1/6" round mild steel and four rods should be used, one in each corner of the post, about $\frac{3}{4}$" from the outside. Two strands of No. 8 wire twisted together can also be used but the twisting is a time consuming business and it is difficult to make them straight. It seems that $\frac{3}{8}$" round steel is more readily available but this size is unnecessarily heavy and expensive. When obliged to employ $\frac{3}{8}$" we have used only three rods per post—one in each of the two bottom corners and one at top centre.

The following are the quantities required for ordinary intermediate fence posts:—

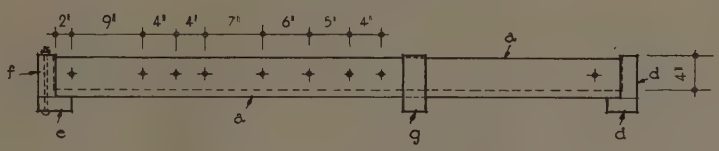
Per Post:—

(*a*) Four lengths $\frac{1}{4}$" mild steel—about 4 lb.	1/4d.
(*b*) 1/36 yard of aggregate—about 80 lb	5d.
(*c*) 16 lb of cement	2/1d.
(*d*) Labour	6d.
	4/4d.

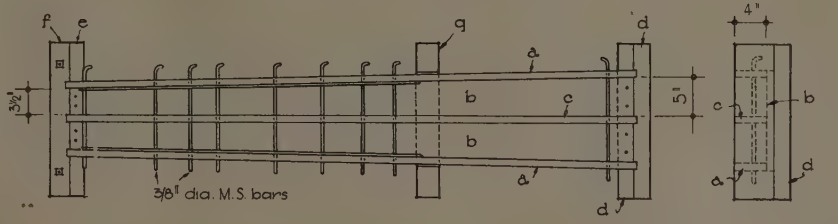
Per 100 *Posts*:—

1/6 ton of $\frac{1}{4}$" mild steel @ £36 ...	£6 0 0.
3 yards shingle @ say 12/6 yard .	£2 0 0.
$\frac{3}{4}$ ton cement @ £16	£12 0 0.
Labour say	£2 0 0.
Approximate cost 100 posts ...	£22 0 0.

• DEPT OF AGRICULTURE FIJI •



• SIDE ELEVATION •

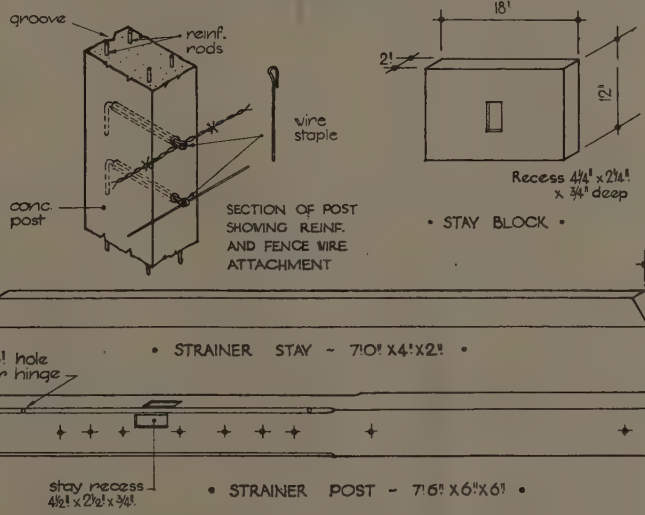


• PLAN •

• END ELEVATION •

CONCRETE FENCE POST MOULDS
AS USED AT THE P A.S. KORONIVIA.

• DEPT. OF AGRICULTURE FIJI •



CONCRETE FENCE POST MANUFACTURE
PRINCIPAL AGRICULTURAL STATION

Post Moulds.—Providing that the posts are 6 feet long and about 4″ × 4″ in section there is no need to be unduly rigid in respect to mould specifications. At Koronivia we have adopted one or two features that we think are an improvement. Once the mould is made it is just as easy to make posts with these improvements as it is to make simpler ones and we feel that with a period of time the small differences are worth while.

For instance our posts are tapered from 5″ × 4″ at the base to 3½″ × 4″ at the top. This secures a small saving in cement and at the same time gives us a post that rams well and firmly into the ground.

Similarly there are a number of different ways of attaching wires to the posts. Some prefer threading the wire through holes in the posts but this is both time consuming and precludes the use of barbed wire. Others simply embed short lengths of wire in the structure of the post as it is being made and twist these over the fence wire. This is quite satisfactory until the embedded wires break off. The method used at Koronivia is considered the best and consists of makingt holes through the posts at right angles to the ultimate line of the fence wires which are attached by wire staples with one long leg which goes right through the hole and is bent over at the back of the post. A small but not strictly necessary refinement is to provide a small groove down the back of the posts into which the long end of the wire staple is bent giving a tidier job than would be secured if the bent ends were fully exposed.

After all once the moulds are made, an almost unlimited number of posts can be made in them, so that a little extra trouble in tapering, providing the back groove etc., is more than recouped by the advantages and the satisfaction of producing a good job.

The paired moulds shown in the sketches have proved very satisfactory indeed, being easy to construct and easy to fill and empty. The timber used should be clean, double-dressed and should be oregon or some other timber that will not warp or twist. The bottom of the mould (*b*), the centre division (*c*), the butt end (*d*) and the bottom portion of the top end (*e*) can be all permanently fixed together, leaving the two sides (*a*) and the upper portion of the top end piece (*f*) removable. The piece (*f*) is attached by bolts as shown and the sides (*a*) and centre board (*c*) are checked in to the ends about ¼″. This means that by undoing the bolts, (*f*) comes away and the sides (*a*) can be removed for emptying and cleaning the moulds. The removal of these side boards makes it possible to empty the moulds after about 24 hours as the posts can be rolled over carefully, whereas if it were necessary to turn the moulds upside down there would be greater risk of breaking the " green " posts.

The ends are each two pieces of 4″ × 2″ and the bottom and sides of 1″ timber. The bottom could, with advantage be made thicker unless particular care is taken to support the bottom to prevent its sagging under the weight of the wet concrete.

At least one support (*g*) is required for the sides and this consists of a wide square " U " shaped piece of wood which is slightly jammed on to the taper of the mould.

The Staple holes.—Again we feel it pays to have plenty of staple holes so that the posts can be used for a variety of types of fence. The " gauge " used is—from the top of the post as follows:—

2″, 9″, 4″, 4″, 7″, 6″, 5″, 4″.

The third hole is really an extra which was included for internal fences of four wires only when numbers 1, 3, 5 and 7 are used. For a full seven wire boundary fence No. 3 is omitted.

To make the staple holes, short lengths of ⅜″ round iron are used and are held in the mould by holes bored through the side and centre boards. These short lengths of round iron should have a couple of inches of one end bent over to make them easier to withdraw.

Filling the moulds.—Before filling the mould it should be smeared with old engine oil. About ¾ inch of concrete is first run in and a pair of reinforcing rods placed in position about ¾″ in from each side. The staple hole rods also oiled, are then put in

position and the mould filled up to within about ¾" from the top when the second pair of reinforcing rods are placed in position. The filling is then completed.

After filling the sides and bottom of the mould should be tapped with a hammer, up and down their full length, several times. This helps to settle the mixture into the corners and also brings a skin of water and cement to the surface of the post which improves its appearance.

It is important that the reinforcing be completely coverred with concrete, and should this be exposed through being too long or through large air bubbles, it will rust and eventually cause the post to break up.

Emptying the Moulds.—After twelve hours or less the staple hole rods can be withdrawn and with care the moulds can be emptied after 24 hours. The posts are easily cracked at this stage and should be carefully rolled out of the moulds on to even supports. After another day or so the posts can be stacked up to mature and may be used in about a month.

After emptying, the moulds should be cleaned down and oiled, whether required again immediately or not.

Strainers, Stays and Footing.—The second series of sketches show the strainer posts and stays used on the Station. As very many fewer of these are made, one mould for each is normally sufficient.

The strainers are 7' 6" × 6" × 6" and are reinforced with four rods of ⅜" round mild steel. Bevelling of the edges is not strictly necessary but improves the appearance and reduces the chances of wires being broken when they are wrapped around the post. Two recesses are provided in the strainers for stays.

Since strainers are often gateposts as well, provision should be made for attaching gate hinges and this is best done as shown in the sketch by making two ⅝" holes diagonally through the strainer. These are made in the same manner as the holes for the wire staples.

The stays are 7' × 4" × 2" reinforced with two rods. One end of the stay is angled back to make it fit the strainer recess. The thrust of the stay when in position, is taken by a slab of concrete, reinforced with wire netting which also has a recess into which the end of the stay fits.

Most fencers have their own preferences with regard to the kind of footing they use. With concrete posts all that is necessary is to provide holes (see sketches of posts and strainers) near the foot and/or just below ground level to which a foot can be attached directly with a bolt or " swinging " with a wire. The foot itself is simply a concrete block about 15" × 4" × 3".

CONCLUSION.

Concrete fencing offers a simple means of building fences that are infinitely more durable than timber and are in consequence substantially cheaper even if the original cost per post is higher and this is not by any means always the case.

The number of moulds required, whether or not a rotary mixer is warranted and so on, are matters that have to be decided by the circumstances. At Koronivia we use 6 paired moulds (produces 12 posts per batch) and it is the first job of a couple of men each morning to empty and refill the moulds. Even at this rate a good supply of posts is soon built up with no disturbance to the general farm work.

MOISTURE CONTENT OF STORED MAIZE

Enquiries are received from time to time as to the proper moisture content at which to store maize in order to keep it for long periods free from mould or from attack by weevils.

A small investigation carried out on the Principal Agricultural Station this year has confirmed expectations that maize stored in other than air-tight containers tends to assume a moisture content figure which is in equlibrium with air moisture and which is largely independent of the original moisture content of the grain.

Three lots of maize in ordinary clean new sacks were used, two were dried on sheets of iron in bright sun and one was left in the "field dried" condition. Early in December, immediately after harvest, the moisture content of the six sacks ranged from 18% to over 20% but this figure rapidly dropped without any treatment until at the commencement of the treatments it was about 12% to 13%.

The following is a summary of the behaviour of the three lots—the figure used being average of four moisture tests in each case:—

Lot A.—Two sacks were thoroughly sun dried until the moisture content was down to 7.4% in early December. About three weeks later, after storage in a sound weather-proof store, the moisture had risen to 11.2% and remained around 10% or 11% during the next six weeks when this lot was again dried down to 8%. During the next month (March) the moisture fluctuated but steadily increased up to about 10%.

Lot B.—This lot was not dried so completely as A and commenced the test period in early December at 10.2%. It rose similarly to A in late January and early February to 11.1%, then fluctuated between 10% and 10.5%.

Lot C.—This received no special drying and commenced the test at 12.6%, falling slightly thereafter until on 1st February all three lots A, B and C were almost identical in moisture content the figures being A—11.1%, B—11.1% and C—11.5%. Since that time until the middle of April when testing ceased, the moisture of lot C has been very similar to B but a few points higher and completed the test at 10.5%.

The test was discontinued in mid April largely because the trial sacks were becoming a nuisance on account of the heavy weevil infestation that had developed. Weevils commenced to infect lots B and C quite early in the test and by February the infestation was quite considerable. The thoroughly dried lot, A was at that time fairly free from weevils which did not become serious until March. By the conclusion of the test, lots B and C were very badly damaged indeed and A was heavily infected.

It seems reasonable to conclude, if maize can be dried down to 7% or 8% of moisture and stored in air-tight containers that weevil infestation would be reduced probably to negligible dimensions, but it is also clear that under ordinary sack storage conditions grain will take up moisture from the air and settle down around 10% or 11% moisture at which figure weevil infestation will develop rapidly and disastrously.

Since few farmers have available the air-tight storage facilities that will protect grain from moisture or permit fumigation, the matter of safe storage in sacks will be further investigated on the P.A.S. Insecticidal materials are on order which are claimed by manufacturers to protect grain from weevils without the ill-effects on stock that may arise from D.D.T. preparations. The results of these investigations will be reported in due course. The large number of moisture tests involved in the above investigation were done by L. A. Vakuru Waibuta of the Station Staff.

—N.L.

FLAVOUR OF RICE

In the course of our Rice Improvement Work at Koronivia we wish to give due weight to flavour—or "consumers preference"—of the varieties under trial, and since this factor cannot be measured in strictly impersonal terms it is difficult to provide for it. We frequently find amongst our visitors some who will express the most definte opinions about the importance of the good eating quality of certain varieties while others equally emphatically consider that yield and general reliability quite outweigh considerations of flavour.

In the absence of any laboratory method for assessing eating quality we felt that the only way to explore the subject was to submit samples of milled rice to a number of people and secure their opinions. Accordingly samples of 12 varieties including three new ones not yet available generally in Fiji were submitted to a group of interested persons under code letters to conceal the variety name as far as possible. No Europeans or Fijians were included amongst the testers as it was considered that few would be sufficiently discriminating to assist us.

No particular indication was given to our graders of the qualities they should look for but they were simply asked to indicate their preferences by grading the samples into five classes as follows—Excellent (5 points), Very good (4 points), Good (3 points), Very fair (2 points), Fair (1 point) and Poor (0 points).

The results can now be summarised as follows:—

Variety.	Range of scores.	Average score.
*B.G. 95/42 ...	2 to 5	4.0
Demerara Creole ...	3 to 5	3.8
B.G. 75	1 to 5	3.5
*B.G. 85/42 ...	0 to 5	3.4
B.G. 79	1 to 5	3.3
*B.G. 54/42 ...	0 to 5	3.1
Ramcajara	0 to 4	3.1
China Patna	1 to 4	3.0
New Guinea	1 to 4	2.3
Motka	0 to 5	2.0
Bandala	0 to 4	0.7

(* New Introductions.)

While this little test cannot by any means be regarded as absolutely final, it has suggested some quite interesting lines of thought and has in fact assisted us to assess the real importance of the flavour factor. The following points should be noted:—

(1) It would clearly be impossible to please all tastes as in almost every case the range of opinions for any one variety range from poor or only fair right up to very good and excellent.

(2) There is no precise agreement between the popularity of varieties and the flavour score they have gained. For instance although the popular B.G. 75 has scored well, the at least equally popular Bandala has scored very poorly. This would suggest that in practice growers do not give a great deal of weight to flavour when deciding upon the rice they will grow. This is true at least for the rice varieties at present in use in Fiji and it may be that all of these are fairly good quality.

(3) The three new introductions have scored well. They are as a matter of fact very similar in all characters to Demerara Creole, B.G. 75 and B.G. 79.

We would like to record our thanks to those gentlemen who assisted us in this test and no doubt as new introductions are made from time to time it could be repearted.

—N.L.

ANIMAL HUSBANDRY . . .

LIVESTOCK IMPROVEMENT—RECENT STOCK INTRODUCTIONS

BY A. F. S. OHMAN, SENIOR VETERINARY OFFICER

In accordance with agricultural policy several pure bred Australian Illawarra Shorthorn and Friesian cattle were introduced to the Colony from New South Wales. Following upon two years' observation it is generally agreed that the stock have not acclimatised as well as was expected. As a result it was decided that the next introductions should be, in the main, high-class grade cattle. These animals, mated with introduced pure bred sires, are expected to produce eventually a more suitable strain of dairy cattle for the Colony's requirements.

In winter of 1951 seventeen Shorthorn heifers were brought from New Zealand. Following upon a period of quarantine they were removed to one of the Agricultural Stations. They have wintered well. It is hoped that they will comprise the nucleus of suitable dairy cattle to be distributed througout Fiji and perhaps other islands in the South West Pacific.

Plates 1 and 2 show groups of the imported cattle at the Animal Quarantine Station shortly after arrival.

PLATE I—Shorthorn Dairy Cattle

Plate 3 depicts a recently imported pure bred Holstein bull. This animal is one of the team of sires being used for herd improvement at the Principal Agricultural Station, Koronivia.

The Department of Agriculture has realised for a long time that pigs and fish could supply a good deal of the animal protein required for a fast increasing population and which could be readily utilised in the Fijian and Indian communities. Among Fijians pigs are understood and the meat is popular. It is hoped that the fishing potentialities of the Colony will be examined.

With the object of distributing good type boars and possibly some gilts in the Colony the Department of Agriculture has imported a number of Large White, Berkshire and Tamworth pure bred animals. (Plates 4-8).

PLATE II—Shorthorn Heifers

PLATE III—Holstein Bull

PLATE IV—Large White Boar

PLATE V—Large White Gilts

PLATE VI—Berkshire Boar

PLATE VII—Berkshire Gilts

PLATE VIII—Tamworth Boar

IMPROVEMENT IN DAIRIES

BY K. J. GARNETT B.V.Sc.

A few days after the hurricane many of the dairies in the Southern District presented a sorry picture of total or partial destruction. Officers of the Veterinary Division decided which could be adequately repaired and which would require reconstruction and in view of the large number in the latter category it was decided that a standard dairy plan would be of considerable assistance. The old plan which was largely outmoded was superseded by a new one drawn by officers of the Division.

In order to enable dairymen to appreciate the advantages of this new plan many of them were taken to sheds at Government institutions which enabled them to see these features in use.

Some men were in a position to go right ahead with rebuilding, but others were not so fortunate. Most had land tenure problems and much time was spent by officers of the Division in expediting transfers and renewals in order that dairymen would have the security of land tenure which the expenditure on their new and better sheds demanded.

The progress made has been most gratifying. Some nineteen sheds out of fifty-one supplying whole milk have been completely rebuilt or renovated and the figures for butterfat sheds are twenty-one out of sixty-five. Ghee dairies have not been concentrated on to the same degree, but even here four have been reconstructed out of a total of forty-one giving a grand total of forty-four virtually new sheds out of one hundred and fifty-seven.

New sheds, however, are only part of the story. Many dairymen are still ignorant of elementary hygiene, furthermore husbandry methods, on many farms, particularly in the more restricted areas of the whole milk producers, are poor. Accordingly a field day was arranged at the Principal Agricultural Station at Koronivia on the afternoon of 28th November, 1952.

Some forty Indian and Fijian dairy farmers, mainly from Suva, Navua and Nausori were welcomed by the Deputy Director of Agriculture when he opened proceedings. The party then moved over to a hillside paddock where the pastures were examined and the importance of rotational grazing in the maintenance of adequate feed supplies, control of weeds and disease were explained. The type of fence and its construction were then explained, particular attention being paid to the proper straining of the wires. It was pointed out that poor fences turn cattle into fence breakers and that once this habit is acquired it is difficult to break hence the importance of sound fences from the outset. Another feature of interest was the concrete watertrough in the paddock which was filled by piped water and controlled with a ball cock. Too many farms have inadequate water supplies and the importance of the availability of good drinking water to the stock at all times was emphasised.

The final item in the paddock was the inspection of the dry herd and there was very favourable comment on the condition and obvious well being of these animals.

On the return to the farm buildings opportunity was taken to inspect the young bulls and it is interesting to note that several dairymen with an eye to business finalised purchases then and there.

Next on the programme was a demonstration of concrete post making and an analysis of the costs involved. Most men were considerably surprised at the ease and speed demonstrated in the actual process and were agreeably surprised that the cost amounted only to some six shillings per post. Officers on the station then gave a demonstration on the footing, bracing and correct ramming of a post.

From this point the party moved over to the dairy where the salient features were pointed out and the system of hand feeding based on the production of the individual

cow was explained. Of considerable interest was the milking machine. Very few farmers had ever seen one before and the working of it was simply and briefly explained to them. Before the cows were brought into the yard several buckets of water were tossed over it to settle any dust and then the importance of quiet handling, proper cleansing of the udder before milking and the use of a strip cup to detect any traces of Mastitis were all stressed in turn. After showing them the milking machine in operation a demonstration in correct hand milking was given.

The next points to receive attention were the proper handling and storage of milk and cream. Good type strainers were demonstrated and then the importance of having the milk still warm when it entered the separator. The inadvisability of mixing freshly separated cream with that which had been standing for some time was also pointed out and the correct procedure and instrument for stirring and liberating the undesirable gases produced in milk and cream were demonstrated. The importance of a water bath in which to stand the cream or milk in order to not only cool it but to exclude ants and the necessity to provide an adequate but not air-tight cover for the can of milk or cream while it was standing were also stressed.

Finally a demonstration was given in the correct procedure to be adopted in washing up utensils. The harmful effect of abrasives and sand soap in the removal of the tinning from buckets was pointed out and it was then shown how utensils would be made clean and bright by first washing them in cold water to remove milk without coagulating the protein contained in it. This is followed by hot water to which a small quantity of soap, caustic or other deturgent has been added and it was explained how this operation quickly removed all grease and left the utensils clean for the final rinse with boiling water which not only sterilised them but as a result of the heat they absorbed caused them to dry quickly without the use of cloths. It was then shown how these utensils should be stored bottom downwards to minimise subsequent contamination.

At the end of the demonstrations, there were many questions asked and it was clear from these that much of the information sewn had not fallen on stony ground. The next steps are to follow up with increased visits to the farms themselves and to increase the scope of these visits to cover the extension of the points stressed in the field day. The more progressive men are showing an interest and appreciation of the problems associated with the production of more and better milk and cream which has been largely lacking in the past and it is hoped to foster a spirit of friendly rivalry and competition which will lead to the acceptance of higher standards of milk products and their production than have hitherto been possible.

PERFORMANCE OF IMPORTED PIGS—KORONIVIA

Three litters have now been secured from the large white gilts imported from New Zealand last year and two of these have grown sufficiently for some idea of their performance to be secured. As a standard for comparison figures are quoted also from the N.Z. Department of Agriculture's bulletin No. 212 for first class litter performance.

	P.A.S. No. 128	P.A.S. No. 129	N.Z. Standard
No. in litter	10	11	8 to 10
Average weight—birth	2.0 lb	1.75 lb	2.5 lb
,, ,, —3 weeks	10.5 lb	9.46 lb	12 lb
,, ,, —8 weeks	32.3 lb	33.19 lb	40 lb
,, ,, —16 weeks	87.4 lb	101.2 lb	111 lb
Litter weight—8 weeks	323.0 lb	385.1 lb	300 to 400 lb

Although we have not reached the N.Z. ideal these performances are very good indeed for first and large litters, bearing in mind too, that while rearing them we have been experimenting with feeding methods also.

Total litter weight at 8 weeks. which is a better index of sow performance than average weight of piglets, compares very favourably with the N.Z. standard and in her second litter, which is not yet weaned, Sow no. 129 has already brought eight piglets to the ideal of 12 lb each at three weeks.

While one likes to achieve a high standard of performance in pig raising, it is necessary to remember also that the fastest fattening rate is not necessarily the most economical. Now that we are satisfied at Koronivia that we have evolved feeding methods that will give high performance we can use these as standards for testing perhaps less efficient but more economical rations.

Meantime there is a brisk demand for our pigs for breeding purposes and any farmers who require stock are advised to place their orders early. —N.L.

Ferguson (TE-A-20) and two-furrow mounted disc plough

VETERINARY . . .

SUSPECTED COPPER DEFICIENCY OF CATTLE IN FIJI

BY A. F. S. OHMAN, SENIOR VETERINARY OFFICER

During the last few years it has been noticed that young stock on the eastern side of the main island Viti Levu have not been doing as well as would be expected. Many have shown a stariness of coat, general debility and in some instances diarrhoea has been associated with these symptoms.

At two of the larger cattle centres Yaqara and Tailevu and about 80 miles apart, livers were recovered from beef cattle and culled dairy stock respectively. These livers were oven dried and air freighted to New Zealand where Veterinary Research Officers of the Department of Agriculture were good enough to undertake quantitative analyses for copper and cobalt.

The figures to hand have suggested that cobalt is present in normal quantities but copper is deficient.

Controlled feeding experiments are now underway and on two selected properties a group of cattle is being fed trace quantities of copper. Another group of a similar number of calves is being used on each place as a control. A number of observations and chemical analyses are being made including monthly weighings of the experimental stock.

It is intended that these expriments should continue for about one year when it is anticipated that sufficient data will be available to judge the necessity or otherwise of feeding a copper supplement regularly.

DISEASES OF POULTRY IN FIJI

(CONTINUED)

BY K. J. GARNETT

A. ROUP DISEASES.

II. GREEN FEED DEFICIENCY DISEASE.

This condition differs from the other forms of roup in that no disease organism is responsible and it is not contagious. In spite of this, the condition is very similar to the other roup conditions in its appearance and there may be confusion in its diagnosis.

Green feed, whether it be in the form of fresh grass, lawn clippings or green vegetables, contains Vitamin A. In many cases yards are too small for the number of birds carried and are quickly denuded of grass and unless the birds are let out to good grass for a time each day or have green feed supplied to them there is a risk that this deficiency disease will develop. Because all birds in the pen are likely to be similarly affected, quite a few birds will develop symptoms together or within a short time of each other and so there may be confusion with one of the infectious types of roup.

Before the typical roup lesions develop there is usually a decrease in egg production and hatchability of the eggs and the birds become unthrifty. Later, if the throat is examined small white pimples or pustules may be seen either in the mouth, on the back of the tongue and in the throat and gullet. In severe cases these pustules may extend to the crop.

At this stage the disease can be checked almost immediately by the addition of Vitamin A in the form of codliver oil or good quality green feed. If the disease is not checked at this stage there is usualy a slight mucoid discharge from the nostrils and this gradualy becomes thicker until the nasal cavities become filled with cheesy material and there is an overflow down through the cleft in the palate.

Still later there is a watery discharge from the eyes and this gradualy becomes creamy in consistence although it is usually white in colour. This material can be pressed out

of the eyes with gentle pressure but it is soon replaced by a fresh accumulation. At the same time there is usually an extension of the cheesy material from the nasal cavities to involve the throat structures and wind pipe. This interferes with the respiration of the bird and it makes numerous attempts to clear its throat. It is important to note that this material is fairly readily removed as it does not adhere very closely to the underlying mucosa or lining.

The severity of the condition and the number of birds that die is determined by the degree of deficiency of Vitamin A. Affected birds may die in a few days or linger for a fortnight or more. Once the eyes are involved death usually occurs in under five days unless the birds are treated. If birds are not treated mortality can be up to one hundred per cent.

Treatment consists of giving the birds Vitamin A preferably in the form of codliver oil if only for a short time and then liberal quantities of green feed. Very severely affected birds should be isolated and fed codliver oil with a dropper at the rate of a quarter of a teaspoonful per bird per day until they show signs of recovery.

Less seriously affected birds should have codliver oil added to the mash at the rate of four per cent for two or three days and then at least one or two per cent until they have recovered and have an adequate source of green feed available to them.

Treatment of the eyes and nose is purely palliative. It cannot cure the condition but does give the birds some measure of relief and if time is available the eyes can be swabbed with cotton wool coated in weak boracic acid solution.

It is important to note that codliver oil or similar fish oils rapidly lose their Vitamin A content under adverse conditions. It is advisable to keep the oil in a dark bottle and away from direct light as far as possible. When being used the oil should be incorporated only in that portion of the mash which is to be used immediately as it breaks down rapidly if left standing in the mash.

As in all conditions, prevention is better than cure. If a poultry owner suspects that his birds have insufficient green feed available to them he should feed a fish oil supplement of some sort at the rate of one per cent in the mash each day. Those people who buy proprietory mashes should be especially careful as they may be misled. Even if oil supplements are added at the time of mixing these mashes the Vitamin A content is reduced to about one sixth of its potency in just over a week in most cases.

Turkeys are very susceptible to this condition. Generally speaking the symptoms and course of the disease are similar to those in fowls.

III. INFECTIOUS LARYNGO-TRACHEITIS.

It is possible that outbreaks of Infectious Laryngo-tracheitis have occurred in the Colony at some time. Because of its heavy mortality rate it is unlikely that an outbreak could pass unnoticed, so it is evident that it does not exist in Fiji at the present time.

The disease is caused by a virus but it appears that any factor which lowers the resistance of the birds renders them more susceptible to an attack of the condition. Such predisposing causes are parasitic infestation, overcrowding, faulty ventilation and bad hygiene. In some cases fowl pox or green feed deficiency lowers the resistance of the birds and they succumb to a superimposed attack of laryngo-tracheitis.

Once the disease has been introduced into a flock the mode of spread is usually by direct contact. Infected birds sneeze and cough and so their neighbours are infected by inhaling the infective material.

Birds which have recovered from the disease are usually immune to further infection but although they appear quite well in themselves, they may act as " carriers " and even some years later may pass on the disease to susceptible birds. This point is of particular importance and should be borne in mind when a new cockerel is being introduced.

Other sources of introduction have been traced to second hand crates which have been used to carry infected birds. Wild birds may drink in the water containers on an infected farm and then visit another poultry run. Poultry mites have also been shown

to carry the virus. Fortunately the condition is not transmitted to the chicken through the egg.

The incubation periods varies as a rule with the severity of the outbreak but is generally from three to ten days with the shorter period associated with acute cases and the longer period with more mild infections.

Birds susceptible include fowls of all ages and pheasants. All other birds appear resistant although they may act as mechanical carriers.

Symptoms are very variable. Peracute cases may just gasp a little, cough up some blood stained mucus and die in a few hours. If they survive for longer periods the condition regresses to less acute or even chronic forms. It must be realised, that there are times when the peracute form is not seen at all in an outbreak and the symptoms are acute or chronic from the outset. Conversely after a few chronic cases are seen the organism may become more virulent and so acute and peracute cases may develop in birds which are infected later. With all these variations it will be seen that it is most diffcult to describe a typical case.

In peracute cases the birds, in the early stages, will swallow frequently, hold the head and neck slightly extended and the mouth is usualy partially opened. A faint gurgling sound may be heard during respiration. There is sometimes a frothy, mucoid discharge from the nostrils and the birds occasionally cough and fling their heads about. The birds become progressively more depressed and later the mucoid discharge may become blood stained and the birds die in a few hours.

This peracute form is extremely contagious and in a few days it is common for up to 80 per cent of the birds to be showing symptoms.

If birds which have died are examined and the trachea or wind pipe slit open it will be found that it is red and congested with blood stained mucus in its cavity. The lining membrane may be partly eroded to leave a raw and bleeding surface beneath.

In the acute form, symptoms are similar but a little less spectacular. There is less blood stained mucus and if the trachea of a dead bird is opened it will be found that there is little free blood in it and instead of being eroded, the mucosa is inflamed and there may be small haemorrhagic blood spotted areas beneath it.

In the chronic form which may follow acute or peracute symptoms or develop as such form the outset there are the typical cheasy deposits which are associated with " Roup " conditions. These deposits which may be found in the mouth, throat, tongue, palate, sinuses, eyes and windpipe are usually preceded by a thin mucoid discharge which gradually becomes thicker over a period of one or two days until the cheesy deposits are formed.

These cheesy deposits interfere with respiration and the birds usually have a shrill cough. If the sinuses are involved they are enormously distended as a rule and subsequent involvement of the eyes usually results in blindness. There is little inclination to eat but a marked thirst is noticed. There is usually an offensive smell associated with the discharges. Birds lose condition rapidly and because they tend to wipe their beaks on their own or their neighbour's plumage, all the birds in the pen soon look most bedraggled and repulsive. Because of the high mortality, up to 80 per cent, it is a disease which poultry keepers hold in dread.

Treatment is practically useless and is not advised. Control can be exercised by vaccination but this must be in accordance with fairly rigid conditions and only under Veterinary guidance. Particular care should be taken in the introduction of birds from other flocks in which there has been suspicion of the disease and faulty hygiene and other factors which are predisposing causes should be guarded against.

ENTOMOLOGY . . .

THE RICE LEAF HOPPER, SOGATA FURCIFERA KOLOPHON, KIRKALDY AND "RICE YELLOWS"

B. A. O'CONNOR

During the last three rice-growing seasons, investigations on the condition known as "Rice Yellows" have been carried out. The work has taken place only on the island of Viti Levu, where nearly 80 per cent of the Colony's rice crop is grown, observations being made mainly in the wet south-eastern corner of the island. There are still many gaps in our knowledge of the disease and the associated insect pest, but it has been thought wise to record the information obtained to date.

RICE-GROWING METHODS IN FIJI.

Subsequent remarks will be more readily understood against a background of knowledge of rice-growing technique in Fiji. In the cultivation of "wet" rice, to which, in normal seasons, Rice Yellows is practically confined, there is very inadequate control of water. Fields are poorly levelled and rainfall and fortuitous seepages constitute the only water supply. The level of the water is seldom steadily raised as the crop grows. The padi fields are surrounded by low "bunds", water being drained off when necessary by breaking an opening in the bund. Even after abundant heavy rains many fields have portions uncovered by water, and during dry periods the water recedes into isolated pools.

The main rice-growing season is during the warm and wet period of November to March, harvesting being at its peak in May. For "wet" rice, seedbeds are sown, beginning in October, the plants being transplanted into the padis about six weeks after sowing. Transplanting takes place mainly in November, December and January. "Dry" rice is sown directly in the field by broadcasting, a small proportion being drilled. A certain amount of rice of the variety New Guinea is grown throughout the year under both "wet" and "dry" conditions.

"RICE YELLOWS" IN THE FIELD.

The disease was first recorded in Fiji in 1938 (1). Since then it has been observed throughout the rice-growing areas of Fiji.

(*a*) *Symptoms.*—Typical symptoms are as follows:—

The leaves begin to curl at the tip, which becomes orange-coloured, and gradually the whole leaf becomes orange and finally dies. Usually the outer leaves of the stool are first affected, wilting and becoming prostrate, and growth is retarded so that the plants are stunted. The whole stool may ultimately be killed, but usually a number of the stems in a stool survive and produce grain.

(*b*) *Time of Occurrence.*—In a normal season the disease occurs during the period from the first half of February until the end of March. The first heavy and continuous rain about the end of March clears up the symptoms and the plants recover. There have been exceptions to this rule. In the 1951-1952 season a drought lasting until well into December delayed preparation of the fields and transplanting. The first cases of Rice Yellows were not seen until the end of February, and recovery was delayed in some instances until towards the end of April. In other years two unseasonable outbreaks of Rice Yellows have been recorded, one in early November and one at the end of April. A number of observers have noted that periods of dry weather seem to favour intensified attacks of the disease.

(*c*) *Site of Occurrence.*—In a normal season Rice Yellows occurs only in portions of an otherwise dry field where water is present either as a stagnant pool or as shallow, flowing water. During the 1951-1952 season, however, the disease occurred over large

areas of fields which were well covered with water. During the same season a very severe infestation affecting whole fields of " dry " rice where no water had been lying was noted by Mr. N. Lamont, Economic Botanist, in the Raki Raki—Ba area. During another more normal season plants exhibiting the typical orange colouration were observed following the line of a foot-path on a dry hillside.

(*d*) *Age of Plants Attacked.*—Symptoms of Rice Yellows have been observed in plants from about four weeks to about twelve weeks after transplanting. Older plants apparently are not susceptible to attack.

(*e*) *Correlation of High Leafhopper Populations and Rice Yellows.*—The correlation between occurrence of Rice Yellows and the presence of very large numbers of the leafhopper *Sogata furcifera kolophon Kirkaldy*, is almost perfect. On only a very few occasions has the disease been observed in places where there were, and had been, few leafhoppers. When plants attacked by the disease and by large numbers of *Sogata* recover, the recovery coincides with a drastic fall in leafhopper populations.

(*f*) *Varietal Resistance.*—During the 1951-1952 season an important observation was made by Mr. N. Lamont in the Rice Variety Trial plots at the Principal Agricultural Station. It was noted that plots of the variety New Guinea growing next to plots of other varieties which were attacked by Rice Yellows were almost or entirely unaffected by the disease. Mr. Lamont noticed a similar occurrence in the Raki Raki—Ba area in early April, where whole fields of rice were severely attacked by the disease, but fields of New Guinea were quite healthy. Questioning of growers has supported these observations. There seems little doubt, therefore, that New Guinea has a strong resistance to Rice Yellows.

(*g*) *Prognosis of Attack by Rice Yellows.*—In the normal occurrence of the disease, i.e. in wet patches in a field otherwise not covered by water, one can predict fairly accurately which areas will be affected by looking for the green patches of crop, even though one cannot see that water is present in these patches. Plants growing in the wet patches have a dark-green and vigorous appearance when compared with surrounding dry areas. After recovery from the disease occurs the remaining plants in the wet patches resume their dark-green colour.

EXPERIMENTS IN INSECTARY.

Experiments on Rice Yellows carried out in the insectary were directed towards obtaining information on the three following questions:—

(*a*) Could Rice Yelows be caused by growing rice in stagnant water ? This line of investigation arose from the opinion of some field officers that stagnation of water in pools in the rice fields caused the disease.

(*b*) Was Rice Yellows caused by the feeding of the leafhopper ?

(*c*) If the leafhopper caused the disease, did it transmit a virus or were the symptoms caused by other factors, such as the injection of a toxic secretion, abstraction of plant nutrients, or other physiological affects of feeding ?

The results were as follows:—

(*a*) *Stagnant Water.*—A number of plants were transplanted into glass pots, with no drainage, in which was placed well-puddled soil consisting of alluvial soil with an admixture of compost. Water was kept at a level about one inch above the soil by occasional addition of small amounts of rain-water. A similar number of plants were transplanted into the same soil mixture and allowed free drainage. These control pots were well watered daily. It was found that the plants grown with no drainage grew and matured much more successfully than those with free drainage. Hence stagnant water alone was considered incapable of producing disease.

(*b*) *Effect of Leafhopper.*—During the 1948-49 season, experiments in the insectary were carried out with rice plants grown from seed planted under an insect-proof cover.

Later it was found that seedlings transplanted from seedbeds in the field did not become infested with leaf hoppers when planted under insect-proof cages. Also the results of Experiment (*a*) showed that stagnant water favoured the growth of rice. Hence, insectary experiments in the 1949-1950 and 1950-1951 seasons were based on plants taken from exposed seedbeds, planted in metal pots without drainage, and covered by insect-proof cages of celluloid and muslin. Thus the plants used in 1948-1949 experiments were younger than those used subsequently, as the latter were six weeks old before being transplanted. The soil used in all the experiments was alluvial soil taken from the river bank, mixed with compost, and well puddled. Water was kept at a level about an inch above the surface of the soil.

In the 1948-1949 and 1949-1950 seasons, when most of the work was done, no proper insectary was available and many experiments were vitiated by factors such as high winds blowing down the cages and scattering the leafhoppers. However, results were quite sufficient to show that *Sogata* can cause Rice Yellows in otherwise healthy plants.

The following tables show the results of insectary experiments in inducing Rice Yellows. Insect-proof cages were placed at the same time over both treated and untreated plants grown from seed, the cages were in placed and the controls. In the case of the plants grown form seed, the cages were in position from the time of planting. In the case of transplanted plants, the cages were used from the time of transplanting. Numerous control plants were used and in every instance these remained quite healthy.

TABLE 1—PLANTS GROWN FROM SEED.

No. of Pot	No. of Plants	Time elapsed after seeding (weeks)	No. of Leafhoppers used	Remarks
1	6	3	Large nos. of nymphs and adults ...	3 weeks later 4 plants dead, 2 dying, after showing symptoms of rice yellows. 5 weeks later plants stunted and yellow.
2	9	7	10 adults 17 nymphs	3 weeks later plants weakly stunted, orange-coloured.
3	11	2	5 adults 16 nymphs	Rice Yellows symptoms 3 weeks later, all plants dead 8 weeks later.
4	12	2	4 adults 16 nymphs	

TABLE 2—TRANSPLANTED PLANTS.

No. of Pot	No. of Plant	Time elapsed after transplanting (weeks)	No. of Leafhoppers used	Remarks
5	4	5	Large no. of nymphs few adults	Rice Yellows symptoms 3 weeks later.
6	4	5½	13 short-winged females	Rice Yellows symptoms 3 weeks later.
7	4	6	108 long-winged females	Rice Yellows symptoms 17 days later.
8	4	2	10 adults 200 nymphs	Symptoms of Rice Yellows 17 days later.
9	4	2	31 male adults 56 female adults	Symptoms of Rice Yellows 3½ weeks later.
10	4	2	140 nymphs	Symptoms of Rice Yellows 3 weeks later.
11	4	2	200 nymphs	Symptoms of Rice Yellows 18 days later.
12	4	3	28 adult females ...	Symptoms of Rice Yellows after 18 days.
13	4	5	Not recorded (Long-winged females) ...	Plants badly stunted and yellowed after 4 weeks.
14	4	5	Not recorded (Short-winged females).	Symptoms of Rice Yellows followed by death of plants.
15	4	5	Not recorded (Nymphs)	do. do.

It will, of course, be realised that the leafhoppers bred very rapidly in the cages. The incubation period of eggs laid in the plant tissue is six days, so that very large numbers of nymphs appear in a short time. In a little over a fortnight after hatching, nymphs reach the adult stage. In sorting out field-collected leafhoppers into males, females, nymphs, etc. the use of carbon dioxide for temporary knockdown of the insects was found very helpful. The source of the gas was " J " size Sparklet Bulbs, used in a holder known as a Resuscitator, which has uses in medicine. The gas can be turned on and off at will.

(*c*) *How Sogata causes the Disease.*—In the experiments described under (*b*), leafhoppers from either healthy or diseased plants produced similar symptoms. Taking this fact in conjunction with others, e.g. the localised nature of the disease in the field, its association with only very large populations of *Sogata,* and the ability of affected stools to recover, it seemed unlikely that Rice Yellows was a virus disease transmissible by insects. No insect other than *Sogata* was considered as a possible vector because the insect population of diseased rice plants, apart from *Sogata,* is negligible, and because of the strong correlation between the occurrence of Rice Yellows and large populations of the leafhopper. The possibility of the injection of a toxic fluid into the plant tissue by feeding leafhoppers appeared to be minimised by the absence of obvious lesions at feeding sites and the fact that small numbers of the insect caused no apparent injury to plants.

Tests to determine whether a transmissible virus disease were involved included attempts at mechanical transmission, using diseased leaves and suspensions of macerated diseased leaves which were rubbed on the leaves of healthy plants, and attempts to produce disease in healthy plants by using large numbers of male *Sogata*. Numbers of adult male *Sogata* collected from diseased plants were placed on healthy plants from one to three hours after collection. The males all died within eight or nine days of being placed on the plants, so that their feeding alone was not likely to have a very adverse effect. Numbers of males placed in individual cages, each of which contained four plants which had been transplanted from two to seven weeks earlier, varied from 55 to 230. All the plants remained healthy. It was concluded that a virus cause of the disease was unlikely, though a great deal of painstaking work would be necessary to establish this theory as a definite fact.

It is thought that the disease is caused by the mechanical and physiological effects of feeding and oviposition by great numbers of *Sogata*. Exceptions to this statements are the very few cases where plants have exhibited symptoms indistinquishable from those of Rice Yellows in the absence of significant numbers of leafhoppers. These could possibly be due to factors such as soil and water conditions which could produce symptoms similar to those of Rice Yellows. However, the known incidence of Rice Yellows not associated with leafhoppers is insignificant.

Various observers have commented on the freedom from the disease of early-planted crops. These early plantings have passed the susceptible stage by the time that leafhopper populations have attained a high level. It is often stated that if growers planted their crops early these would be free from Rice Yellows. However, it is thought that if there were a general move towards early planting the disease might also occur earlier in the season. The question at issue is whether meteorological influences or abundance of suitable food are the main factors in building up populations of *Sogata*. As young rice plants appear to be by far the preferred food of the leaf hoppers, it seems likely that the latter might attain their maximum populations at the time when the maximum areas of young rice crops are available. In that case, disease-free crops could be expected only if plantings were carried out in advance of the main plantings for the season.

EXPERIMENTS IN THE FIELD.

For varius reasons these have been rather sketchy to date. They have consisted of spraying and dusting with DDT with the related objects of (*a*) determining the controlling effect of DDT on *Sogata* and (*b*)

preventing or controlling outbreaks of Rice Yellows. A fairly extensive spraying trial was carried out by Mr. N. Lamont at the Principal Agricultural Station during the 1950-1951 season, with the objects of preventing Rice Yellows in the sprayed area, but no results were obtained as the disease did not occur in either sprayed plots or controls. In the 1951-1952 season it had again been intended to conduct spraying trials for prevention of Rice Yellows. Inspections of rice plots on the Principal Agricultural Station revealed only low populations of *Sogata* up to early February, when the Rice Yellows season is normally about to begin, so preventive spraying was not carried out. When symptoms of the disease appeared in some plots towards the end of February, spraying for control was undertaken. Spraying and dusting experiments are briefly discussed below.

(*a*) *Control of Sogata.*—(1) *Seedbeds.*—During the 1948-1949 season it was thought that control of *Sogata* in seedbeds might greatly reduce the numbers of the pest on transplanted rice. Three small plots about 64 square yards each were sprayed in diffirent seedbeds. Each was sprayed with DDT in the form of 50 per cent Dispersible Powder and 20 per cent Emulsion, applications being very heavy, ranging from 2½ lb to 5½ lb of actual DDT per acre. One plot was sprayed once, ten days before transplanting, the second plot twice, 32 and 16 days before transplanting, and the third plot at weekly intervals from seeding until transplanting. None of these treatments had any effect on populations of *Sogata* in the transplanted crop. In the seedbeds there were few adults and no nymphs in the treated plots, while the untreated areas gradually built up large populations of adults and nymphs. The few adults in the sprayed plots were probably individuals which migrated from the surrounding unsprayed areas. The fact that crops transplanted from the treated plots built up just as large populations of *Sogata* as those from untreated areas indicates that hatching of nymphs from newly transplanted material is not important in building up field populations of the leafhopper. Very likely the wilting which occurs is freshly transplanted material causes the death of emerging nymphs through lack of food.

(2) *Field Crops.*—Six different plots were sprayed or dusted with DDT. The dust used was 2 per cent DDT, and rate of application was not calculated. The sprays consisted of 20 per cent DDT emulsion, about one part to one hundred of water by volume. Rates of application varied with the age of the crop. Machines used were rotary dusters, knapsack sprayers and a portable mist blower. Some of the treated areas were already affected by Rice Yellows, others not. Size of treated plots varied from 20 square yards to 3 acres with adequate control areas. In all cases excellent control of *Sogata* was obtained with almost 100 per cent kill of adults and nymps within 24 hours. Hatching nymphs also suffered practically 100 per cent mortality, so that one spraying or dusting almost completely eliminated *Sogata* populations and re-infestation was slight during at least a fortnight after treatment. However, spraying is to be preferred to dusting where practicable, as it is cheaper and can be expected to have a better residual effect than dusting, since the dust may be washed off by heavy rain.

(*b*) *Control of Rice Yellows.*—The experiments mentioned above, in addition to three plots of 1½ square chains each sprayed by Mr. Lamont, provided observations on control of Rice Yellows. As mentioned earlier, the fairly large scale spraying conducted at the Principal Agricultural Sataion in the 1950-1951 season for prvention of Rice Yellows were vitiated by the absence of the disease from both sprayed and unsprayed plots. Preventive spraying on small plots in the 1951-1952 season, with one exception, suffered a similar fate. Hence the results of attempts to control or suppress Rice Yellows by application of DDT are not as convincing as they might be. However, the overall picture indicates that such prevention or control may be confidently expected. Moreover since *Sogata* causes the disease and is very efficiently controlled by DDT treatments, control of the diseases may be expected to follow such treatments. Some details of experiments in which treatment with DDT appeared to have a definite visible effect on the crop are given in Table 3. The dust used contained 2 per cent of the p-p'isomer of DDT and the sprays 0.15 per cent.

Plot No.	Area of Plot	Age of crop(1)	Treatment	Rice Yellows(2)	Remarks
1	1 sq. chain	5-6 wks.	Dusted twice, Feb. 14th & 20th ...	Yes, in wet patches ...	Feb. 24—Rice Yellows much improved in plot. Control unchanged. March 10—Effects of disease much more obvious in untreated area than in Plot 1.
2	20 sq. yds.	1 mth.	Sprayed March 6th ...	No	Observations made March 15 and 22 and April 28. Neither treated nor untreated areas affected by Rice Yellows. At each observation, treated plot taller & greener than untreated area(4).
3	20 sq. yds.	5 wks.	Sprayed March 7th ...	No	Observations made March 15 and 24 and April 17. March 24—Unsprayed area in same depression as Plot 3 had Rice Yellows. Sprayed plot unaffected by disease. April 17—Sprayed area obviously greener, taller and more dense than remainder of field.
4(3)	1½ sq. chains	6 wks.	Sprayed March 4th ...	Yes, in wet patches ...	March 15—Sprayed plot greener and healthier than unsprayed. Many more dead stems in unsprayed area.
5(3)	do.	do.	do.	do.	do.
6(3)	do.	do.	do.	do.	do.

Present information indicates that the best time to spray the crop with DDT for prevention of Rice Yellows would be about five weeks after transplanting. At this time the first generation breeding on the plants would be reaching the adult stage. It is hoped that in subsequent rice growing seasons the efficacy of DDT treatments for prevention of Rice Yellows may be convincingly demonstrated in field experiments.

BIONOMICS OF SOGATA FURCIFERA KOLOPHON, KIRKALDY.

The female leafhopper lays its eggs side by side in the tissue of the leaf-sheath or the midrib of the flag. The eggs are about 0.8 mms. long and 0.2 mms. wide at the widest part, broadly rounded at one end and narrowing to a rounded cone at the other. The operculum is situated at the narrow end and is pushed aside when hatching of the nymph occurs. As the time for eclosion approaches, the egg increases in size to a length of 1.0 mms. and a width of 0.25 mms., and the red eye-spots of the embryo can be seen towards the narrow end. The site of the egg laying can be detected by noting brownish areas of dead tissue in which the slit made by the ovipositor of the female may be seen. After hatching occurs, the empty egg-shells may be seen protruding from the slit. In caged rice plants in the insectary as many as eighty eggs have been counted in 30 mms. of midrib.

Other host plants on which the leafhopper is known to breed are Barnyard Millet (*Echinochloa crus-galli*) and Crowsfoot grass (*Eleusine indica*). No doubt there are other hosts. However, the most favoured host appears definitely to be rice, and migration from crops other than rice is apparently a factor of little importance.

The incubation period of the egg is six days during the summer months, when the mean daily temperature is about 80°F.

(1) i.e., time between transplanting and treatment.

(2) i.e., whether diseased or not at time of treatment.

(3) Plots 4, 5 and 6 were treated by Mr. N. Lamont at the Principal Agricultural Station. There was no significant difference in yield between the sprayed plots and the controls.

(4) Indicating that, though Rice Yellows did not occur, plants in the untreated area were adversely affected by **Sogata.**

There are four nymphal instars, the first males becoming adult fourteen days after hatching and the first females sixteen days after hatching. Twenty-one days after hatching all nymphs have reached the adult stage. The adult leafhoppers have lived as long as thirteen days in cages, but a week would be a more normal length of life. Pre-oviposition period of the adult female is two days. Hence, a complete generation occupies an average time of about four weeks. the shortest time being 24 days (6+16+2).

The infestation of a young rice crop is begun by migrating adults. Though a seed-bed may have been heavily infested by *Sogata,* and many eggs may have been laid in the young plants, material transplanted into insect-proof cages from such seedbeds remans free from leafhoppers. Evidently the wilting which occurs after transplanting is sufficient to terminate the infestation of the seedlings. This is confirmed by field observations, for a newly transplanted crop is seen to harbour only adult leafhoppers. The exception to this statement occurs when transplanting is carried out in a field immediately adjacent to a crop which is infested with *Sogata.* In this case nymphs are able to move from one field to the other. Where seed is sown directly in the field the newly germinated plants also have only adult leafhoppers. It appears that the adult leafhoppers are strongly attracted to young fields of rice and have considerable powers of flight. Moreover, they migrate to young broadcast rice growing in quite dry fields with a readiness apparently equal to that with which they invade wet padis. Dry fields of young rice removed from other fields by a distance of 10 chains have been seen infested by large numbers of adult leafhoppers about a fortnight after the first leaves appeared above the surface of the soil. As only a scattered few *Sogata* could be found on surrounding weeds and para grass, these adults during their short life must have been attracted to the young rice and migrated thither from a considerable distance.

Field observations show that the leafhoppers tend to occur in their greatest numbers in portions of an otherwise dry field where the soil is covered by water. During the day they congregate on the lower few inches of the rice-stalks, and during heavy infestations this part of the outer stalks of a stool may be almost completely covered by the insects. Copious honeydew is secreted, and this produces a growth of black fumagine. Nymphs and adults can float on the surface of water, and if disturbed they fall onto the water and may be borne along by wind and current. A dark form of the leafhopper commonly occurs during heavy infestations and brachypterous females are also found. Infestations appear to be favoured by fine, dry weather so long as pools or streams of surface water still remain, and the termination of an infestation, which is usually quite sudden, generally coincides with a period of several days of heavy rain.

NATURAL CONTROL OF *SOGATA*.

Several parasites and predators attack *Sogata* in the field, though they are apparently not capable of preventing or controlling outbreaks. These are the *Mirid* bug, *Cyrtorhinus vitiensis* Usinger, a *Trichogrammatid, Ologosita* sp., and a *Mymarid, Anagrus sp.* near *frequens* Perk., all of which attack the eggs, a *Dryinid, Haplogonatopus sp.,* and a *Strepsipteron, Elenchus sp.,* which attack nymps and adults. *Haplogonatopus sp.* is parasitized by the *Encyrtid, Echthrogonatopus exitiosus* Perkins. The *Mirid* bugs, *Cyrtorhinus mundulus* Breddin and *C. riveti* Cheesman are often found in small numbers in fields of rice infested by *Sogata,* so they also may attack its eggs. There is also a fungus which attacks the leafhoppers during wet and humid weather.

The only one of the abovementioned species which has been studied is *Cyrtorhinus vitiensis.* This species was described by Professor Usinger in 1951 from specimens collected in Fiji (2). Its performance when caged in the insectary indicated that it could be a very efficient predator on the eggs of *Sogata,* but it has been unable to suppress the pest under field conditions. It appears to be quite numerous in rice fields during the earlier part of the growing season, but its numbers decline as the season advances, while populations of *Sogata* are increasing rapidly.

C. vitiensis is a small, agile insect about three millimetres long, the head and prothorax being mainly black and the rest of the body a bright green. The eggs are laid singly in the leaf-sheath and in the midrib of the flag. They are 0.80 mms. long and 0.25 mms. wide, and are curved. They appear to have a double chorion, the outer chorion having a raised reticulation at the anterior end, with processes projecting from either end of the flat operculum. The inner chorion has a structure at the anterior end which has the appearance of heavily chitinised lips. From the slit between the lips the hatching nymph emerges and pushes off the hinged operculum. The eggs can readily be seen in the leaf under a low magnification, as the processes on the operculum make them fairly conspicuous.

The incubation period of the eggs it about seven days and the nymphal stages occupy 19 to 22 days at a daily average temperature of about 80°F. Adults lived as long as 19 days when confined on rice plants on which *Sogata* was breeding. When 28 adults *C. vitiensis* collected in the field were placed on rice plants free from leafhoppers all the bugs died within five days, so that apparently they cannot feed on the rice plant. When these plants were examined it was found that seven female *C. vitiensis* had laid 86 eggs during the few days of confinement, and all of these eggs had been completely emptied of their contents. Thus, it appears that the bug will suck its own eggs, which may be a factor limiting its reproduction in the field.

When nine adult *Cyrtorhinus* and 100 adult *Sogata* (23 males, 67 females) were placed on young rice plants, no *Sogata* nymphs were seen to hatch, so that the bug exerted complete control. In a control cage where a similar number of *Sogata* were introduced without *Cyrtorhinus* large numbers of nymphs hatched and the plants developed severe symptoms of Rice Yellows. In another cage 14 adult *Cyrtorhinus* were introduced with 135 adult female *Sogata* and some nymphs and adult males. Only a few *Sogata* nymphs emerged instead of the very large numbers which would normally have done so. Many eggs of *Sogata* were dissected from the leaves and examined and all were found to have been emptied of their contents. Thus it would appear that *Cyrtorhinus vitiensis* is potentially an efficient predator on *Sogata*, and we have no explanation of its poor performance in the field. One possibility is that it is still in the process of adapting itself to rice crops. In this connection, *Sogata* was first recorded in Fiji early in the century, but it was not until 1938 that it came under notice as a pest of rice. This seems to indicate that *Sogata* only gradually and slowly became adapted to the rice plant, since this crop has been grown in Fiji for many years. It seems possible that the same process may be taking place in the case of *Cyrtorhinus*, which was first collected in Fiji in 1948. If this is so it may be hoped that ultimately *C. vitiensis* may bring about effective control of the leafhopper in rice fields.

Acknowledgments.—Grateful acknowledgment is made of the interest and co-operation of Messrs. N. Lamont, Officer in Charge of the Principal Agricultural Station, and M. D. ffrench-Mullen, formerly O.I.C. of the Station. Our thanks are due to the Commonwealth Institute of Entomology for the identification of insects.

[NOTE.—Since this article was completed, an experiment in the insectary has shown that Rice Yellows may be induced in New Guinea rice plants. Four cages, each containing six potted transplants of New Guinea, were stocked with *Sogata*, and four similar cages were kept free from leafhoppers. The leafhoppers bred freely on the New Guinea plants and typical stunting of growth, followed by yellowing, occurred in the four treated cages, while the controls remained healthy.]

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AN INTRODUCED PARASITE OF NOOGOORA BURR

B. A. O'CONNOR

The seedfly, *Euresta aequalis* Loew, which breeds in the fruits of the weed Noogoora Burr, (*Xanthium italicum*) is established in Queensland in the vicinity of Brisbane, having been originally introduced to Australia from U.S.A. It exerts no significant control of the Burr in Queensland, where the plant fruits at only one season of the year, and the fly has only one annual generation. The larva passes the winter and early summer months in a state of diapause.

In Fiji the Noogoora Burr plant fruits thoughout the year. It was thought that the larval diapause of *Euaresta* might not be obligatory, and that the fly might complete two or more generations each year in the warm and equable climate of Fiji. In this case it might bring about control of its host plant.

Mr. A. P. Dodd, of the Biological Section, Department of Public Lands, Brisbane, kindly agreed to collect burrs from the area where the seedfly was established. In May, 1950, he collected about 100,000 burrs, of which he estimated that 30% contained parasites. This was a much higher rate of parasitism than the normal. It was decided that the burrs could not be imported to Fiji, owing to some risk of introducing larvæ of the Cattle Tick. Hence it was decided that the writer should visit Brisbane and arrange for dissection of the burrs, returning with puparia and larvæ in diapause.

The period actually spent in Brisbane was only a week, Jan. 31 - Feb. 7, 1951, which was considerably less than had been intended. However, as adults had begun to emerge from the burrs, and most of the larvæ had pupated, it was thought wise to hurry back to Fiji. Consequently the bulk of the burrs had to be left undissected. Mr. F. A. Perkins, Lecturer in Entomology at the University of Queensland, kindly made available a laboratory, and recruited students on vacation, who carried out the dissection of the burrs. Sixty adult *Euaresta*, 2,362 puparia and 1,367 larvæ were finally brought back to Fiji. Of these a small proportion was damaged, and a number of puparia were lost during the first two days owing to fungus attack, due to keeping the puparia and damp *Sphagnum* moss. It was found better to place the puparia on a wire gauze tray, under which damp moss was kept.

Liberations were conducted at Sigatoka, where large areas of Noogoora Burr occur along the valley of the Sigatoka River. Puparia were kept in an insect-proof box, covered with a dark cloth. Flies could emerge into twelve glass tubes, access to which could be controlled by a sliding shutter built into the front of the box. The box itself was housed in a movable quarantine chamber.

It was found that 88% of undamaged puparia yielded adults, and a high proportion of the larvæ in diapause pupated and ultimately produced adults. The larvæ were stored between layers of cottonwool in 2 oz. tobacco tins which had squares of 64 mesh phospher-bronze gauze soldered into top and bottom. The tins were kept in an airtight box containing damp sphagnum moss. Puparia also keep well in such tins.

Formation of puparia by larvæ in diapause was continued until April 14, 1,104 puparia being produced from the 1,367 larvæ, some of which were damaged. A few healthy larvæ had still not pupated. The duration of the pupal period was from 23 to 28 days, in the majority of cases being 25 or 26 days.

Emergence of adults, which had begun in Brisbane early in February, was still occurring when the writer proceeded on leave on April 20. Indications were that emergences would continue until mid-May. The maximum emergences occurred during the three days February 23-25, when 356 adults emerged (176 males and 180 females). The earlier emergences showed a preponderance of males, the later having a higher proportion of females. Emergences during the

period to April 16 totalled 2,240, of which 1,120 were males and 1,120 females. It was calculated that about twenty more adults would emerge during the next month.

Mating was noticed on one occasion between a male and a female which had emerged only two days before, but usually the first matings occurred four or five days after emergence. Pairs kept in cages were seen to mate several times. Longevity of caged adults fed on honey water was up to eight weeks, the majority surviving for more than seven weeks.

Liberations of adults in the field totalled 2,049 (1,033 males and 1,016 females), and took place during the period February 8 to April 7, the site of liberation being at Naduri village, on the bank of the Sigatoka River, where extensive areas are occupied by Noogoora Burr. The first 250 flies were set free within one day of emergence, but the remainder were kept in cages for some time before liberation, partly to allow some mating to occur, and partly because headquarters had been moved 100 miles from the liberation site. Some of the flies were kept as long as three weeks before liberation, the average time in cages being between a week and ten days. Sixty pairs were known to have mated before liberation, and no doubt further matings had taken place.

All emergences took place in a small quarantine chamber which could be moved by truck from place to place. No hyperparasites were observed.

As the writer proceeded on leave on April 20, there was little opportunity to investigate breeding in the field during the first season. On April 7, two larvæ of *Euaresta* were found in burrs collected at Naduri, one of these being shrivelled, and the other healthy and fully fed. On April 10 the healthy larva assumed the flattened appearance characteristic of larvæ in diapause. During 1952, many thousands of burrs collected near Naduri were dissected. During April, three larvæ which are thought to be those of *Euaresta* were found, one being first instar and the other two second instar. At the end of June, two more second stage larvæ were taken. As none of the larvæ had reached the final instar, they could not be identified with certainty. It is as yet too early to make any statement as to whether the seed-fly is established or is likely to exert any control of Noogoora Burr.

A factor which may have adversely affected *Euaresta* was a severe flooding of the Sigatoka River at the end of January, 1952. The water rose above the tops of the tallest vegetation in the area where liberations were made.

NOTES ON THE LIFE-HISTORY OF THE COCONUT LEAF MOTH, AGONOXENA ARGAULA MEYR

S. R. SINGH

These moths are yellowish brown in colour and are 5 mm. to 9 mm. in length. The females can be distinguished from males by the white stripes on their wings and moreover by the possession of pointed ovipositors. The male moths have dull cream stripes on the wings and comparatively slender abdomens. The moths are nocturnal in habit, but the larvæ feed greedily on the green tissue on the underside of leaves both day and night, leaving the upper epidermis, which turns brown on drying.

Eggs.—Moths lay eggs on the underside of the leaves—on leaf tips and along the midribs in continuous lines and singly. The eggs are oval in shape, measuring 1.0 mm. by 0.5 mm., and are pale green in colour. The incubation period varies from 7 to 9 days with an average temperature of 80°F.

Larval Stages.—The eggs hatch in the night and the newly emerged larvæ are pale yellow in colour and are about 1.5 mm. long. They are very active and move rapidly over the leaves and spin a thin white silken web under the cover of which they feed. The first moult usually occurs about 3-4 days after hatching, the larva being then 2.5 mm. in length.

The second moult occurs 3-4 days after the first moult. The larva turns yellowish green and becomes about 5.4 mm. long.

The third moult takes place 3-4 days after the 2nd moult. The larva measures 8.5 mm and turns more green in colour.

The 4th moult takes place 3-4 days after the 3rd moult. At this time the larva is about 22 mm. long and feeds voraciously for 4-6 days.

Prepupal and Pupal stages.—The full grown larva then prepares an oval, light brown, silky cocoon measuring 15 mm. by 6mm., within which it rests for two days (prepupal period) in an inactive state and then it undergoes a final moult, changing into a complete pupa. The pupa is dark brown in colour measuring 6 mm. in length and 1.75 mm.-2.0 mm. in width. Duration of pupal period is 9-10 days with an average temperature of 80°F.

The moths emerge in the night and mating takes place on the night of emergence or on the 2nd or 3rd night. The pre-oviposition period is 24 hours, eggs being laid three nights after mating.

Most of the eggs are laid on the 6th-9th nights after mating.

Both sexes seem to have the same longevity—average being 19 days. The moths do not seem to be attracted to light (tested with pocket flash light bulb.)

KORONIVIA

THE PRINCIPAL AGRICULTURAL STATION OF FIJI

NORMAN LAMONT, ECONOMIC BOTANIST

INTRODUCTION

INTRODUCTION.

The imminent, if not already present, failure of our world to cater adequately for the nutritional needs of its persistently growing population, makes increased food production the most urgent of the world's needs and there is no doubt that basically many of our sociological, political, racial and international problems depend for their final solution upon improved agricultural techniques and more efficient utilisation of undeveloped or ineffectively farmed areas.

A group of farmers at the first general field day.

The older countries of the world over many generations have evolved a highly efficient and well organised pattern of agriculture that is stable, productive and conservative in the best sense of the word, but which offers little hope of substantial expansion. Such significant increase in world food production as has taken place over the last century has been almost wholly the result, and often at the expense, of the virgin fertility of new countries such as the North American continent and the British Dominions.

Visitors inspecting pasture plant introduction plots.

Rapid development of these areas was possible, too, because the methods of agriculture which were successful up to a point at least, were simply those evolved in the older temperate countries. The simple basic pattern of agriculture which was successful in England and Europe, was also sucessful in North America, in Australia or New Zealand and although modification has been necessary, particularly in the interests of soil conservation this has been more concerned with detail than with essentials.

It is completely accepted in all countries that the problems of agriculture are both too urgent and too vital to be left to the limited resources of private individuals. All countries, even the most primitive, have established Government financed institutions whose function is to investigate new methods and to bear the cost of the losses inevitable to this exploration of novel techniques. Too often, unfortunately, the number and the support given to agricultural research institutions reflects the existing level of prosperity in the country rather than the size and complexity of the problems requiring solution.

It is the recognition of this difficulty that has prompted organisations such as F.A.O. to assist backward countries and the British Government to make generous grants to its Colonies to assist in the establishment of agricultural stations where they are most needed which is often not the place where they can be most easily afforded.

It was in this way that Koroniva had its genesis and the cost of capital establishment has been largely born by the British Government through the Colonial Development and Welfare Fund.

SPECIAL NATURE OF TROPICAL PROBLEMS.

In addition to the relative lack of development capital and of appreciation by the population of the need for agricultural stations there are, too, from the technical point

of view major and fundamental problems facing tropical research stations that do not concern most similar institutions overseas. As was mentioned above the broad pattern of farming in more advanced countries was evolved either *in situ* or adapted from countries of similar climate where they had been evolved though the accumulated wisdom of generations of yeoman farmers. Apart from primitive bush-fallow systems no such traditional pattern has evolved in tropical countries. Rather has the emphasis been laid on—generally profitable—plantation crops from the export of which much of the country's food requirements have been paid. Such subsistence agriculture as has grown up beside the plantations has often been primitive, ill-organised and relatively inefficient.

Whereas oversas research institiutions are concerned mainly with the embellishment of practices and techniques already efficient and systematised, the urgent need in many tropical areas is nothing less than creation of a new agriculture. We are required not only to attempt to improve separately the various elements that comprise a farmer's business but at the same time to weld these together into an organic and smoothly functioning whole. Unlike overseas stations we cannot work on a single factor with complete foreknowledge of its place in the scheme of things but we have literally to evolve basic and systematic patterns of agriculture composed of these separte factors functioning in harmony.

The recognition that we must adopt a more fundamental outlook than our overseas colleagues is reflected in policy and activities of Koronivia in innumerable ways. Clearly it is an enormous task and clearly too we cannot expect in a small Colony the staff and other facilities that would enable us to subject each and every piece individually and in all conceivable combinations and permutations to thoroughly critical and searching examination. On the contrary, the task is one for the judgment of experienced agriculturalists working in the closest possible association with the more progressive farmers

Milking herd and dairy.

The new piggery completed in September, 1951.

of the Colony. Initially at least the most rapid progress will come from careful observation and sound judgment and only partially from the more accurate but much more exacting and slow methods of precision experiment.

HISTORY OF KORONIVIA.

This need for " evolving or balanced system of land usage " was pointed out by Messrs. Patterson and Dodds whose report on agricultural policy in Fiji when accepted by Legislative Council became virtually the charter of Koronivia. These gentlemen rightly considered that it was from the non-cane growing lands of the wet zone that the best prospects of increased food production lay. They recognised that first and foremost the station must be representative of substantial areas of the Colony and that also if possible, it should be located sufficiently close to centres of population to provide those ordinary amenities without which a stable staff of family men is difficult to secure.

While retaining the old Sigatoka Station for special dry zone work it was therefore decided to locate the Principal Agricultural Station at Koronivia, eleven miles from Suva on a site comprising both red clay uplands, well drained silt flats and deep swamps. None of the soils of Koronivia are rich, most of the 250 acres of upland country are unploughably steep and of the 150 acres of flats only 50 acres are naturally fairly well drained and the remainder are quaking swamps at least in the summer.

On the Station we have in short all the problems of the wet zone hills and swamps to which the Colony must look increasingly for food production. Insofar as we share their problems just so far may we expect to contribute to the majority of wet zone farmers in the Colony.

It is not always easy to state precisely when a Station of this kind comes into being. Late in 1948 a start was made with relocating previous tenants, with laying out of fence

lines and drains and with the siting of buildings. During 1949 dairy cattle were purchased, a few farm buildings erected and in November, 1949, the first Officer-in-Charge, Mr. M. D. ffrench-Mullen and the Farm Manager, Mr. W. Gordon, took up residence on the property. Since June, 1950, the writer has been Officer-in-Charge.

These three years have been full years and much has been accomplished. It seemed appropriate at this stage to rceord this progress not only perhaps for our contemporaries, but against the day when, having attained the venerable reputation of a Rothamstead, Koronivia may be the more interested in its origins.

GENERAL DEVELOPMENT.

The Station is primarily a farm and it has developed much as a farm should, with due respect for the maintenance of a proper balance between its varied but closely related activities. The areas of crops grown for experimental purposes have been determined not solely by the interest in or importance of the crop as such but by the need for a systematic arable farming programme. Similarly our pasture development programme has progressed not in accordance with our dislike of guava, burr and rubbish but in balance with our increasing stock numbers.

In view of our primary aim which is in simplest terms to learn to farm this area systematically, efficiently and profitably, it is important to remember that in dividing this account into sections for convenience of recording, a very artificial element is introduced. Our farming and our Station is a single entity and each of its elements, whether human or agricultural, has repercussions on all other elements. Sound farming is never a series of disconnected events but always a continuous and dynamic process, and although to save undue repetition this may not be obvious in this sectionalised record, it an essential basic consideration of very great significance.

Interior of milking shed.

FENCING AND DRAINING.

On our assumption of it, the property had no fences worthy of the name and many miles have been erected. At first wide use was made of electric fencing and a measure of control of stock was quickly secured but it soon became obvious that the life of the light posts used was very limited and more recently concrete posts have become standard. As reported elsewhere we have found that we can make these posts as cheaply as we can buy wooden ones or more cheaply when we use bamboo strips for reinforcing.

The common tendency amongst farmers, particularly short term tenants, is to disregard the value of their own labour and they are quite prepared to spend time repairing fences to the point where complete if piecemeal renewal every two or three years is the rule. It was soon apparent, under our conditions where all labour costs money, that we could not afford or for that matter continue to make permanent progress with our subdivision, unless we discarded wooden fences completely.

Drainage is one of our major problems. An excellent skeleton system of open drains was established by the first Officer-in-Charge and these have become increasingly effective as soil coditions in turn improved under their influence. We now have 50 acres that can be termed " arable " in any normal season and a further 20 acres or so which we can generally depend upon during the drier season.

The key to our whole drainage system is our main outlet into the Toga branch of the Rewa River. Following the keeping of river level records over a period of a year and in consultation with drainage engineers of the Public Works Department, this outlet has now been deepened considerably and increased in capacity. We can now expect that all of our swamp can be coverted into good arable. There is little doubt, however, that the full utilisation of these areas will not be possible unless and until some satisfactory form of underground drains are secured. At the moment we are commencing investigations into concrete pipe drains and as with fencing, we feel we cannot afford to dissipate labour indefinitely in such work as the perennial cleaning of open ditches.

Permanent fences to make possible the proper control of stock and their efficient manipulation in the interests of pasture improvement plus thorough drainage to permit the full and mechanical utilisation of heavy soils, are we believe, prerequisites of the type of farming we visualise for Fiji.

DAIRY FARM AND DAIRY STOCK.

Koronivia is situated in the centre of the Colony's dairying industry and the problems of the dairy farmer in Fiji are our problems. Much of our work with dairy husbandry is not and does not need special experimentation, but arises incidentally to ordinary dairy farming with the great advantage that on the Station we can exercise a much greater measure of control and if necesary deliberately invite trouble in order to secure information. For instance, at our 1951 Field Day the writer expressed regret that the absence of calf mortality on the Station had prevented us from studying this problem and hoped that as numbers grew the occasion would arise. From our point of view, we say fortunately, this has now occurred but only spasmodically. At the moment, an experiment is being designed with the deliberate object of inducing this disorder in a few calves in order to throw light on the problem.

Our foundation herd of 33 animals were Friesians of which all but 6 imported from Australia were purchased from the Fiji Pastoral Company. This Company has now been breeding Friesians for many years in a tropical environment under the direction of their most able Manager, Mr. R. Little, and we are very satisfied indeed with the quality of the animals. It will be our policy to seek always to grade the herd upwards with high quality imported bulls and already there is a keen demand from local farmers for our bull calves.

Recently a small local herd of very well bred Jerseys has also been acquired and a herd of this breed will also be established. When the Station is fully developed it should be possible to milk perhaps 150 cows and probably by that time the separation of the Friesians and Jerseys will be justified with a separate milking shed to save undue travelling and congestion.

Dairy stock at the moment total about 150 head and because of our stage of development there is inevitably an undue proportion of young animals and this will persist until a stable herd is developed. Approaching 60 cows are milked with an average daily production of about 100 gallons. These figures are only moderately satisfactory and are not likely to improve so long as we are seeking to build up numbers in order to extend our grazing areas. At the moment the most arrant " passengers " are retained in the herd for this reason and until our numbers permit us to cull we cannot expect improvement in average figures. It should perhaps be said that bull calves from good cows only are kept for sale as breeding bulls the remainder are castrated. All producers are fed meals in the bails at a rate depending on their production and averaging about 2 lb per gallon of milk produced.

Our main grazing area for the dairy herd is the upland country a portion of which has been very successfully planted with Batiki bluegrass (*Ischaemun aristatum*). This area is being subdivided into 2½ to 3 acre fields to which a trough water supply is provided. We believe that when we can rotationally graze with sufficient intensity a cycle of increased carrying capacity and pasture quality improvement will be initiated, the ultimate success of which is difficult to forcast without being thought excessively optimistic.

The dairy herd provides the grazing units for arable rotation studies, good quality breeding stock for the Colony and opportunity of controlled study and experiment on the problems of health, production and management. It provides also an opportunity for training and demonstration, including the use of milking machines, which were installed in June, 1951. Fijian Staff have quickly learned machine milking and handle the equipment competently.

PIGGERY.

Following the completion of our new piggery, built to a station design by station labour, a home was provided in September, 1951 for the large white gilts ad boar imported from New Zealand.

This section also is now performing its main functions which are to supply breeding stock, to investigate feeding and management practices generally and to provide training and demonstration in efficient pig husbandry. Already our standard of litter performance compares favourably with overseas figures and litter weights approaching 400 lb at 8 weeks are being secured.

POULTRY SECTION.

The same general functions apply to the poultry section as to the dairy stock and pigs except that the opportunity seems to exist for a more spectacular contribution to the Colony's needs. As staff and labour are now becoming trained we are proposing to expand this section considerably with purpose of supplying a large proportion of the day old chick requirements of Fiji which are at present imported. There is no reason why this should not come to pass by 1954 and further development will depend upon demand. It may well be that we could supply hybrid chicks well suited to the sometimes rugged conditions of local management and indirectly relieve the chronic local shortage of eggs and poultry meat in a fairly short space of time.

RICE IMPROVEMENT PROGRAMME.

Rice is the staff of life in Fiji and is a crop probably worth over £1,000,000 annually to the Colony. Since too it is an annual crop that lends itself to rapid improvement, we were able as well as anxious to allot the highest priority to rice improvement work and this commenced very early in the station's history in 1949.

A full report of our work will appear elsewhere and suffice to say at the moment that we felt that the quickest resutls would be secured from improvement in varieties used, rather than from any substantial change in peasant cultural practice. Accordingly, the past three years have been devoted principally to selection and trial of existing and recently imported varieties.

While it has become clear that many varieties in fairly common usage are best discarded, it is also true that there remain an unnecessary number of quite good varieties

which could be recommended for use in the wet zone. We believe that confusion results from a superfluity of varieties and in consequence have reduced our recommendations to the simplest possible terms. It has become very clear that time of planting is most significant in determining the variety to be sown particularly in view of its relation to the " Rice Yellows " condition. For rice sown in the nursery beds not later than mid-November and planted out not later than New Year, the varieties B.G. 75* and Ramcajara can be confidently recommended but if planting is delayed the risk of " Rice Yellows " developing is considerable. A variety such as New Guniea is likely to give more certain and better yields from later plantings.

Closely related to our varietal work has been the investigations of cultural practices generally with particular emphasis on mechanisation. Our variety trials have included machine drilled as well as hand-planted trials and it is quite clear that the above recommended varieties are equally satisfactory for both methods. Savings in cost by machine drilling are of course very great indeed but until more satisfactory methods of mechanical harvesting are available the development of rice as a profitable cash crop is unlikely. Towards this objective we have made enquiries throughout the world for rices that resist lodging and shattering. Already over twenty new rices have been secured for trial this year.

In view of its known relative resistance to rice yellows and, in other respects also, its relative indifference to time of planting, a selection project on New Guinea rice was commenced in the 1951-52 season. From about 8,000 single plants a small group of 20 have been selected which appear to excel in certain characters that we require. This year's work will determine whether these characters are genetic in basis and whether from these selections we may be able to produce a superior type of New Guinea.

We feel that our rice improvement programme is very important indeed and it is a perennial project. In many parts of the world breeding work is proceeding with staffs and facilities immeasurably greater than ours but we will be able to exploit this overseas work by continual introduction and trial of new varieties as they become available. When the value of these is established, seed will be increased on the station and sold to farmers. At present we are producing, within our overall farm programme, from ten to fifteen tons annually of pure seed of proven varieties. If as growers are exhorted to do, this was used entirely for further seed production, the bulk of the Colony's seed padi requirements could be based, in one year, upon Koronivia seed with spectacular effects on overall production.

CROP ROTATION STUDIES.

We regard our crop rotation studies as perhaps the most important work of the station although they are unspectacular, slow-moving and apparently vague in expressed objectives. The word vague is scarcely correct and the appearance only arises because the work is so very broad in scope, so very long term in its applications and at this stage, merely opening up the preliminary exploratory phase of an enormous subject.

At the risk of over-simplfication it might be said that the *raison d'etre* of any crop rotation system is soil fertility maintenance in its broadest sense. Elementary textbooks sometimes compare soil with a trading bank and as most of us fully appreciate, no more comes out of our banking account than we put into it—or if we are overdrawn, not only must this be remedied promptly but it also costs an additional amount to do so.

The fundamental purpose of our crop rotation or soil management studies is, therefore, to determine under local tropical conditions how to draw upon the land most profitably, in the short term view while ensuring at the same time that sufficient deposits of fertility are made to keep our account on the right side in perpetuity. The bush-fallow system did satisfy this conditions where there was ample surplus land to allow a non-productive period of fifteen to twenty years or more during which time the land could recover

* It is necessary to record that the varieties B.G. 75 and B.G. 79 were confused at the time of their importation into Fiji. To attempt to correct this locally would only lead to pointless confusion but overseas readers should note that 75 should read 79 and vice versa.

for a further three to five years of cropping. The purpose of our work is to ascertain how the bush-fallow can be replaced by a fertility building element in the rotation which will not only restore fertility more efficiently but which will if possible give us some return in produce while doing so.

Green manuring is one attempt to answer this problem and a green manuring rotation is included in our studies, but while we do not wish to anticipate results, we do not feel confident that green manuring is very efficient and of course it yeilds no return of itself. In temperate countries pasture and livestock are the fertility builders and we can see no reason why results similar in principle may not be secured here. Clearly the practical considerations are radically different— the crops we use, the order and manner in which these are grown, the grasses and their management, the programming of activities so as to use labour and machinery most regularly and efficiently, the manipulation and management of the grazing animals—all present problems that are essentially our own and cannot be solved for us.

The elements which we are seeking to combine into a profitable and productive arable farming system are root crops such as tapioca and kumala, the cereals—rice and maize and both long and short rotation grasses or forage plants for dairy cow grazing. This work has a significance, too, beyond immediate agricultural considerations as the efficient welding of field crops with livestock production can be expected to have important repercussions on human nutrition, already somewhat lacking in animal protein and protective foods such as dairy products.

We have four main rotation plans in operation each subdivided into variations on the main theme and already a very considerable amount of information of immediate practical value is accumulating.

A fifth rotation experiment involving sugar cane has also been in operation for almost two years and we have much pleasure in recording that we have the close co-operation of the Colonial Sugar Refining Co. in this work.

This is essentially long term work but if we expect to secure information that may serve as a basis for a land-use policy in the Colony for maybe a hundred years there is no justification for impatience.

OTHER CROP IMPROVEMENT WORK.

Part and parcel of our crop rotation studies are efforts to improve the culture of native food crops. In addition to the rice work already recorded, collections of varieties of tapioca and kumalas are being built up for trial and investigations are continuous into mechanisation techniques, the use of artificial fertilisers and so on. Unlike rice, native root crops have been vegetatively reproduced for very long periods by a native race of considerable agricultural competence and we do not anticipate being able to contribute significantly to the Fijian's own knowledge of varieties and their utilisation. We do expect, however, to provide the answers to the incorporation of these crops into an up to date arable system and particularly to their culture by modern mechanical means which should change them from labour consuming subsistence into possibly profitable cash or even export crops.

TREE CROPS.

Until its complete destruction by the recent hurricane the Koronivia nursery was already providing some thousands of trees annually for both economic and amenity planting but by and large the full implementation of our tree crop programme lies some years ahead.

The acquisition of good varieties, their trial and final production of seedlings for sale of tree crops such as citrus, avocado, mangosteen, tea, coffee, cacao and perhaps rubber are very long term projects indeed and we cannot claim to have done more than barely initiate work in this field.

GRASSLAND STUDIES.

It is only over the past twenty years or fewer that many of the most advanced agricultural countries in the world have begun to appreciate the potentialities of grass as a productive, nutritious crop and par excellence as a soil saver and fertility builder. As recently as seven years ago the writer

found may areas in the U.S.A. for instance where grass was regarded as a necessary evil relegated to poor quality steep land unfit for serious cultivation.

Gross production of grassland in the tropics is very high indeed and the yields of green matter of the order of 20 tons per acre or more which can quite easily be expected compare more than favourably with any other crop. In the wet zone at least seasonal production is extraordinarily even by overseas standards and there seems no reason why a high level of efficiency in tropical grassland farming should not be developed in Fiji.

Although a policy of continued introductions of promising species from other tropical countries is still being followed and these are grown for observation at Koronivia, we feel that species already introduced into the Colony by accident (as Para appears to have been) or through the long sustained introduction work of Mr. B. E. V. Parham and others, will provide us with ample material. Para grass Batiki blue grass, Woolly finger, Nadi blue and Guinea plus Elephant grass or *Kavinondo sorghum* for short rotation purposes only await full utilisation to serve as the basis of a highly productive grassland agriculture.

Our concerns at Koronivia in respect to pasture are threefold—for our flats we need both a short term and a long term grass for our arable work and for the unploughable hills a truly persistent perennial.

While Para is clearly a " natural " for wettish flats and none could fail to be impressed by the very good results being obtained from this grass at both Tailevu and Navua, we may confess to a predisposition towards a short turfy grass amenable to highly intensive rotational grazing treatment. At Koronivia on the better drained flats at least both Batiki and Woolly Finger are most promising and we believe will give us a pasture from which every mouthful is protein-rich, fibrelow leaf. On the unploughable country Batiki blue seems the answer and its aggressive dominance over weeds is a most valuable trait.

We have, too, small areas under grazing of Centrosema and Puero both in association with Batiki and Woolly Finger, which at times approach the apparent ideal of a dairy pasture and we would hesitate to discount the frequently reiterated claim for an efficient tropical pasture legume.

On the other hand, we do feel that there may not yet be, in Fiji, a sufficient appreciation of the rule that efficient, intensive grazing techniques can play in building up—literally—the fertility and the productiveness and nutritive value of pasture. We will continue to explore the utilisation and particularly methods of establishment of legumes such as Centro but we do suggest also that a careful watch be kept on our now closely subdivided hill pastures where we believe in two or three years time occasional dark green vigorous protein rich patches now present will have coalesced into a cow to the acre sward of which any country could be proud.

CONCLUSION.

The effort required to condense into the above brief account the first three years of Koronivia does in itself encourage us to feel that we have made progress not only in the array of buildings, equipment, crops and stock but in the foundations laid first towards the building of a farm and also towards making a sound and practical contribution to the Colony's agricultural progress, we feel that something has been accomplished. Little has been said of the accumulation of records and experience, often tedious in the keeping, which will prove a most valuable fund of information in the future and to set out in detail the investigational and research projects that force themselves on our notice daily would require more space than this present account.

Perhaps we should remind both ourselves and our contemporary or future critics of the hundreds of " man-years " of technical skill and effort that have made our Rothamsteads and our Ruakuras and be content to feel that Koronivia is at least a lusty infant. Looking back to the wilderness of swamp and guava of a brief three years ago we

do enjoy the sight of our arable flats despite the swamp still ahead of us, we have pride in our 2¼ tons per acre of B.G. 75 as well as being impatient at its lodging propensities, in our 57 milkers and 90 odd youngsters whose production must be made better than that of their dams and we do claim progress both materially and in greater awareness of the problems ahead.

Much more remains to be done at Koronivia than has yet been done but it is a place in Fiji—a place in the South Pacific—a place that is already home to the over one hundred souls of all races who live within its boundaries and, we may hope, a place that will contribute to the security and the prosperity of all of the homes of all of the peoples of Fiji.

PYRETHRUM INSECTICIDE

The Department of Agriculture has a limited supply of Pyrethrum powder which is available for sale to the general public at the following very reasonable prices:—

Old Stock—2s. a tin (half pound).

New Stock—3s. 6d. a tin (half pound).

Small quantities of DDT for mixing with pyrethrum sprays can be made available to purchases of the latter. The price is 6d. per ounce.

The Entomologist has provided the following notes on the many uses for pyrethrum in the garden and the house. It is a most effective and reliable material for controlling a wide range of garden and domestic insect pests.

Pyrethrum powder is a very powerful insecticide, its most outstanding characteristics being—

(*a*) rapid knock-down effect;

(*b*) lack of toxicity to warm-blooded animals, making it very safe to use; and

(*c*) lack of residual effect.

2. The principal uses of pyrethrum as an insecticide are as follows:—

(*a*) as a household spray or dust, to control houseflies, mosquitoes, cockroaches, ants and bed-bugs;

(*b*) as a treatment for head-lice and pubic lice of humans;

(*c*) as a louse-powder for poultry;

(*d*) as a flea-powder for dogs and cats;

(*e*) as a dust for control of banana scab moth;

(*f*) it may also be used as a spray for flies in dairies, for treating mosquito-breeding tanks and other water holding vessels, and for moths infesting copra and other stored products. As a dust it can be used against plant-feeding insects.

3. The effectiveness of pyrethrum sprays is enhanced by the addition of DDT, which adds residual effect to the characteristically quick knock-down of pyrethrum. Most proprietary household sprays include pyrethrum and DDT or some similar lasting insecticide. It must be remembered that pyrethrum kills insects by contact, and therefore must be thoroughly applied, as only those insects actually coming in contact with the spray or dust are killed.

4. A spray fluid may be made from pyrethrum powder by adding one pound of powder to one gallon of lighting kerosene. The mixture is allowed to stand overnight, and is occasionally shaken up. Finally it is filtered through fine muslin and ¾ fluid ounces of methyl salicylate is added, to give a pleasant aroma. To increase the efficiency of the spray, it is advisable to dissolve three ounces of technical DDT in each gallon of the extract. For preparing large quantities of spray material, the following method has been found useful:—Holes are punched in the bottom of a large metal drum, and a tightly-packed layer of cotton-wool is then placed on the bottom. The required quantity of pyrethrum powder is then placed on top of the cotton-wool and the lighting kerosene poured on. The extract passes through the cotton-wool and drips slowly into a container below. Methyl salicylate and DDT are then added to the extract.

5. Pyrethrum powder and spray material should be kept in tightly closed containers in a dark place, as exposure to light and air causes rapid breakdown of the toxic principle.

6. Use of pyrethrum sprays and dusts against various insect pests—

(*a*) *Houseflies, mosquitoes, ants.*—Spray directly on to the insects, and where possible keep the room closed up for half an hour.

(*b*) *Head-lice and Pubic-lice of humans.*—Spray the affected areas, using an atomizer, and rub thoroughly into the hair. After one hour wash with soap and water. If it is desired to allow time for treatment of the patient's bedding, clothes, etc., the washing may be postponed for 24 hours. All stages of the insect, including eggs, are killed by this treatment. Infected eyebrows may be treated with an ointment containing one part of pyrethrum powder in eight parts of vaseline. As this preparation does not kill the eggs, it should be applied each night for a week.

(*c*) *Cockroaches.*—Scatter pyrethrum powder alone or mixed with borax in the haunts of the pests.

(*d*) *Bed-bugs.*—Thoroughly spray cracks and crevices in floors, walls, bedsteads, etc., where bugs hide during the day.

(*e*) *Fleas on dogs and cats.*—Place the animal on a sheet of newspaper, and dust freely with pyrethrum powder. The fleas fall on to the paper, and are then placed in a fire.

(*f*) *Poultry lice.*—Dust birds, nests and sandbaths with the powder.

(*g*) *Banana Scab Moth.*—Apply to the young bunch with a puff-duster. This method is well-known in Fiji.

(*h*) *Plant-feeding insects.*—The dust may be applied to insects which can be actually contacted, but pyrethrum is not the best insecticide for this purpose.

7. When large quantities of dust are being used, economy may be effected by mixing one part of powder with three parts of talc.

—W.J.B.

STAFF NOTES

The following staff notes cover the period June to December, 1952.

Mr. W. J. Blackie, Deputy Director of Agriculture since 1947 has been transferred to Hong Kong as Director of Agriculture, Fisheries and Forestry. A note on Mr. Blackie's Service record is published elsewhere in this number of the *Journal*.

Mr. A. R. Browning B.Sc. (N.Z.) A.N.Z.I.C. and Mr. P. A. Bonhote Dip. Applied Chem. (Tas.) have joined the Chemical Division of the Department as Assistant Chemists. Mr. I. T. Twyford B.Sc., A.R.I.C. has also joined the division as Soils Chemist associated with the Soil Survey of Fiji.

Mr. N. Coster B.Sc. (Agric) T.D.A. has joined the Department as Agricultural Officer and is stationed on the Sigatoka Agricultural Station.

Mr. H. Hardie M.R.C.V.S. (Edin) has been appointed to the vacant post of Veterinary Officer and has been stationed at Lautoka in the Western Division.

Mr. L. W. Harwood, Agricultural Officer Southern is taking a course of study including cacao propagation and cultivation for the T.D.A. diploma at Tropical School of Agriculture, Trinidad.

Dr. W. J. Payne, Animal Husbandry Officer on leave in the United Kingdom is renewing contacts with animal research centres and is taking a special course of study at the Hannah Institute.

Mr. R. R. Mason, Agricultural Officer, while on leave in England is studying development in Mechanisation and prior to return to the Colony will visit Malaya to study rice growing in that territory.

Mr. N. Lamont, Economic Botanist and Officer in Charge of the Principal Agricultural Station proceeded on leave to the United Kingdom in December.

Mr. C. Vasey, Produce Inspector returned from leave in Australia in November. Mr. Vasey made a special study of plant quarantine and inspection and fumigation methods in operation in Australia. During his absence from the Colony Mr. A. B. Ackland, a former Produce Inspector, acted as Produce Inspector.

Mr. B. E. V. Parham, Senior Agricultural Officer attended the meetings in Noumea of the Research Council of the South Pacific Commission. Mr. Parham is a Member of the Council.

Mr. B. A. O'Connor, Senior Entomologist, spent two months in New Guinea investigating the biological control of Scab Moth of the banana. A parasite has been introduced for breeding up and liberation in Fiji and others are to be subsequently investigated. Mr. O'Connor also discovered an additional parasite of Agonoxena pest of coconuts which looks promising.

Mr. A. F. S. Ohman, Senior Veterinary Officer accompanied by Livestock Officer R. S. Vera and Veterinary Assistant Fred Mua Fatiaki were successful in landing 47 head of selected Hereford stock in the Solomon Islands. The stock were transported on the R.C.S. *Kuri Marau* and were required as beef breeding stock for Ilu farm. On his return Mr. Ohman visited New Guinea and Brisbane for study of livestock developments and discussions on livestock problems.

Mrs. C. Davidson, M.A. Librarian and Editor of the *Journal* has resigned from the Department. Mr. W. J. Blackie, Deputy Director has taken over the duties of Editor and Mr. Wright has been appointed Librarian.

Mr. S. Bharat, Dip. Agric (Allahabad) Agricultural Assistant, has been promoted Senior Agricultural Assistant. Mr. Bharat joined the Department in July, 1929, and has served in many districts of the Colony as Field Assistant and latterly in the Northern Division as Agricultural Assistant in the Extension Services.

Mr. N. S. Miles, Dip. Agric (South Australia) has been appointed an Agricultural Assistant and is stationed on Sigatoka Agricultural Station where he is at present acting as Animal Husbandry Officer.

Mr. J. D. Dorrity has been appointed an Agricultural Assistant (temporary) and is stationed at Lawaqa in the Extension Services.

Mr. R. F. Burness has been appointed as an Agricultural Assistant and is stationed at Headquarters.

Apakuki Tuitavua has returned to duty after completing a course of meat inspection in Sydney. The Department is proud of Apakuki who captained the Fiji representative team in its recent successful tour of Australia. Apakuki had previously captained a representative Fiji team against a touring Maori side. The late Vilitati Vaivaitamana, a Laboratory Assistant also had the honour of captaining a representative Fiji Rugby team and it would appear that the Department of Agriculture is not lacking in football talent.

OVERSEAS VISITORS

Dr. G. H. C. Herklots, Secretary of the Colonial Agrcultural Research Council visited the Colony to examine the proposals under projects A.R. 1, A.R. 2 and A.R. 3 of the Development Scheme. Dr. Herklot's visited Sigatoka and Koronivia Agricultural Stations and following his investigations and recommendations the Secretary of State agreed that funds should be provided from Colonial Development and Welfare Funds to carry out the projects.

Dr. H. Green of Rothamstead Experimental Station and Adviser on Tropical Soils to the Secretary of State visited the Colony to examine the proposals for the Soil Survey and to discuss with local officers problems of soil classification. Visits were made to Koronivia and Sigatoka and soils were examined in other localities. Dr. Green was accompanied on tour by the Deputy Director of Agriculture and the Senior Chemist.

Mr. D. Urquart formerly Director of Agriculture, Gold Coast Colony visited Fiji to examine the possibility of establishing a Cocoa industry. Mr. Urquart who is a cocoa specialist was employed by the South Pacific Commission to examine conditions for cocoa cutivation in the territories covered by the Commission. In the course of his survey he visited the British Solomon Islands Protectorate, Papua New Guinea, Samoa and Fiji.

Mr. Urquart visited the wet areas of the Northern and Southern Division of the Colony of Fiji and was accompanied on tour by the Deputy Director, Senior Agricultural Officer, Senior Chemist, Economic Botanist and Agricultural Officer Southern. He considered that a Cacao industry could be successfully established in Fiji.

Of considerable interest to the Colony was the visit of *Mr. W. V. D. Pieris* a Coconut Specialist employed by the South Pacific Commission. Mr. Pieris is making a survey of the industry throughout the regions which are the concern of the Commission.

During his stay in Fiji Mr. Pieris was accompanied on tour by the Deputy Director of Agriculture and the Senior Agricultural Officer and visits were made to the main coconut areas of the Colony. His observations and recommendations are awaited with interest.

Dr. E. M. Ojala the newly appointed Deputy Chairman of the Research Council of the South Pacific Commission visited the Colony on two occasions to examine progress with agricultural and livestock projects which are grant aided by the Commission and to discuss matters and problems of common interest to South Pacific Territories.

Aonther visitor from the South Pacific Commission was *Mr. J. L. Dumbleton* the recently appointed Plant and Animal Quarantine Officer of the Commission. Mr. Dumbleton was mainly concerned with the Rhinoceros Beetle problem and visited Samoa and Tonga in the course of his enquiries.

Mr. J. C. Gerlach who has been appointed Agronomist (Tropical Section) New Zealand Department of Agriculture spent three weeks in the Colony studying agricultural conditions and the work of the Extension and Research Services of the Department of Agriculture.

Other visitors were *Mr. Rossin* (Secretary General L'Office de la Reserche Scientific Outre-Mer), *Dr. Norman D Newell* (Geologist American Museum of Natural History), *Mr. L. C. Lee* (Research Officer Kimberly Research Station, W. Australia), *M. Lasalle Sérè* (Senior French Commissioner South Pacific Commission), *R. A. Eden* (Manager Reparation Estates Western Samoa), *W. Straatmans* (Director of Agriculture Tonga), *Mausia Tu'iono* (Produce Inspector Tonga), *J. Linsley Gressitt* (Pacific Science Board Bishop Museum Honolulu) and *Dr. Kroon* (Executive Officer Economic Development South Pacific Commission).

VALEDICTORY

MR. W. J. BLACKIE, M.Sc. F.R.I.C., F.N.Z.I.C.

(FIJI SERVICE 1929-1953)

The staff of the Department of Agriculture and his many friends throughout the Colony have recorded their congratulations to Mr. W. J. Blackie on his transfer on promotion to the post of Director of Agriculture, Fisheries and Forestry, Hong Kong.

Mr. Blackie joined the Colonial Service in 1929 when he was appointed Government Chemist, Fiji. During his years of service he has seen a great expansion in the staff and facilities available for the Chemical services and has been largely responsible for many important developments in that branch of the Department's work. In 1937 he was awarded a Commonwealth Fellowship under which he studied Nutrition at Yale University, United States of America, and visited agricultural Research Centres. During the war period (1942-44) he carried out several important chemical investigations for the United States military forces in Fiji and for a time had under his dircetion in the Laboratory a group of American chemists. He served with the Home Guard of the Fiji Military Forces.

Durnig his service as Deputy Director over a period of five years he was much concerned with the administration of research services and with the development of laboratory and station services. As chairman of the Department's Research Committee he has been largely responsible for the progress made under the Colony's Development Plan with the establishment of the Agricultural Stations at Koronivia and Sigatoka. These important projects have reached an advanced stage due to his active interest and keen practical direction. He has always urged the need for research and investigation as a basis for sound agricultural extension work and development and it is largely through his efforts that the soil survey of the Colony was undertaken.

In 1949 he was a delegate to the Seventh Pacific Science Congress.

He has acted on several occasions as Director of Agriculture ; and as an official member of Legislative Council and has served on Select Committees dealing with Service and Colonial matters. He has served as a Member of the Council of the European Civil Servants Association on many occasions and was Chairman of the Council during the 1946 and 1950 re-organisation periods. His efforts on behalf of the Service have earned the appreciation of his colleagues in all departments of the service.

Throughout his long service of 23 years in Fiji Mr. Blackie has published nearly 50 articles in the *Agricultural Journal* and in overseas *journals* on chemical, livestock and agricultural topics, on soils nutrition and processing of copra and other products. He is the author of a Departmental Bulletin on *Copra and Copra Drying*. Being particularly interested in the field aspects of the Department's services he has spent considerable periods in the field and is consequently well known to the farmers and planters throughout the Colony.

He has also devoted much time and energy to unofficial organisations. He has been President, Rotary Club, Vice President Fiji Society and Fiji Club and is a keen member of the Fiji Golf Club.

He leaves the Colony with the best wishes of all his colleagues in the Department and of a host of friends amongst all races.

—B.E.V.P.

AGRICULTURAL ADVISORY COUNCIL

A full meeting of the Agricultural Advisory Council took place in December and several matters of considerable importance were discussed and recommendations made to Government.

The current investigations programme of the Department was endorsed by the Council. It was suggested however that dairy farmers should be consulted before certain grasses are eliminated from the investigations programme.

The Council was strongly of the opinion that every endeavour should be made to establish a Cacao industry in Fiji and supported the work being undertaken by the Department at Naduruloulou.

The coconut and banana industry came up for discussion. With regard to the former the Council after a review of the present state of the industry revealed in the Survey Paper by L. W. Harwood published in this issue of the *Journal* agreed to defer recommendations until the report of the Rehabilitation Committee was available. In the case of the latter industry prospects of further development were reviewed including the possibility of extending production in Savu Savu, Lomaiviti and the Sigatoka River Valley.

A discussion took place on the matter of land reclamation for rice and other food crops and the Council gave full support to departmental proposals which have been placed before the Economic Review Committee.

The Department placed before Council its view on a scheme to make available to farmers certain implements and farm machinery from a pool at Koronivia. After some modification the terms and conditions of hire were approved by the Council.

A memorandum was submitted to Council dealing with proposals to import certain livestock for study and further with the support of the South Pacific Commission that Fiji should become a centre for livestock introduction and distribution to other South Pacific territories. In the first instance it was suggested by the Chairman that *Santa Gertrudis* beef stock should be the first importation.

The Council supported in principal the proposals which covered sheep, goats, dairy cattle, beef cattle and pigs but recommended that costs of development and maitenance of the project and the possibility of collaboration with local stock owners should be further investigated.

Members' items dealt with a wide variety of subjects of direct concern to the practical farmer including the production of day old chicks, artificial insemination, weeds in rice, earmarks for goats and the availability of rice and grazing land. Fijian members were concerned with tapioca production, the weeding of Fijian coconut holdings and the planting of Cacao.

The matters raised by members are receiving the attention of departmental officers.

The Council congratulated the Director of Agriculture on the excellence of the Annual Report for 1951.

—W.J.B.